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U.S. Army Corps of Engineers
New England District

FINAL
LONG TERM MONITORING PLAN

AREA OF CONTAMINATION 69W
DEVENS ELEMENTARY SCHOOL

DEVENS, MASSACHUSETTS

CONTRACT NO. DACA31-94-D-0061
DELIVERY ORDER NO. 001

MARCH 2000

DISTRIBUTION STATEMENT A
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HLA Harding Lawson Associates

FINAL
LONG TERM MONITORING PLAN

AOC 69W
DEVENS ELEMENTARY SCHOOL
DEVENS, MASSACHUSETTS

Prepared for:

Department of the Army
U.S. Army Corps of Engineers, New England District
Concord, Massachusetts

Prepared by:

Harding Lawson Associates.
Portland, Maine

CONTRACT NO. DACA31-94-D-0061
DELIVERY ORDER NO. 001

MARCH 2000

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

1. REPORT DATE *(DD-MM-YYYY)* 15 March 2000	2. REPORT TYPE Final	3. DATES COVERED *(From - To)* 1995 to Present
4. TITLE AND SUBTITLE Final Long Term Monitoring Plan AOC 69W Devens Elementary School Devens, MA		5a. CONTRACT NUMBER DACA-31-94-D-0061
		5b. GRANT NUMBER N/A
		5c. PROGRAM ELEMENT NUMBER N/A
6. AUTHOR(S) Rod R. Rustad		5d. PROJECT NUMBER 45001
		5e. TASK NUMBER 9144.09
		5f. WORK UNIT NUMBER N/A
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) Harding Lawson Associates 511 Congress St. Portland ME 04101		8. PERFORMING ORGANIZATION REPORT NUMBER N/A
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) USAEC Aberdeen Proving Ground, MD		10. SPONSOR/MONITOR'S ACRONYM(S) SFIM-AEC-ER
		11. SPONSOR/MONITOR'S REPORT NUMBER(S) SFIM-AEC-ER-TR-200009

12. DISTRIBUTION/AVAILABILITY STATEMENT
Distribution Unlimited:
Approved for Public Release Statement A

13. SUPPLEMENTARY NOTES

14. ABSTRACT

See Executive Summary

15. SUBJECT TERMS

~~N/A~~ LTMP

16. SECURITY CLASSIFICATION OF: a. REPORT	b. ABSTRACT	c. THIS PAGE	17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
"A"	N/A	N/A	None	100	Rod R. Rustad
					19b. TELEPHONE NUMBER *(Include area code)* 207 775-5401

Standard Form 298 (Rev. 8/98)
Prescribed by ANSI Std. Z39.18

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This Long Term Monitoring Plan (LTMP) describes the groundwater monitoring and institutional control inspections to be performed at Area of Contamination (AOC) 69W, Devens, Massachusetts. This Plan was developed for the U.S. Army Corps of Engineers (USACE), New England District (NAE), by Harding Lawson Associates (HLA) under Contract No. DACA31-94-D-0061 Delivery Order No. 001.

Contamination at AOC 69W is attributed to heating oil that leaked from underground piping in 1972 and in 1978. A soil Removal Action performed by the Army in 1997-1998 eliminated the majority of the petroleum-contaminated soils that would otherwise be a continuing source of contamination at AOC 69W. Contaminated soil within a limited area adjacent to and underneath the school that exceeds soil standards was left unexcavated due to structural concerns for the building. This soil is below a paved area that minimizes any further migration of contaminants and potential future exposure. Under current conditions, AOC 69W poses no unacceptable risks to human health or the environment. Risks associated with hypothetical future exposure to AOC 69W groundwater as a drinking water source exceed levels considered acceptable by USEPA due largely to elevated concentrations of arsenic. This is a worst case scenario as there are currently no drinking water wells at AOC 69W and the school is serviced by a municipal water supply. The soil Removal Action performed in 1997-1998 will act to lessen reducing conditions in the groundwater and therefore arsenic concentrations are expected to continue to decrease.

The Record of Decision (ROD) for AOC 69W was signed on June 30, 1999. "Limited Action" was the selected remedy for AOC 69W groundwater and subsurface soils. The ROD specifies that the following key components be included in the selected remedy at AOC 69W:

- A Long Term Groundwater Monitoring Plan is developed to monitor for any potential off-site migration of contaminants and to verify that elevated concentrations decrease over time.
- Institutional controls, including deed and/or use restrictions, are established and enforced that restrict or prevent potential human exposure to site soil and groundwater contaminants left in place.
- Five-year reviews are conducted to review the data collected and to assess the effectiveness of the remedy.

This LTMP details the program that will be initiated to sample and test the groundwater, and to evaluate site conditions to verify that institutional controls are being met.

Groundwater monitoring will consist of sampling a total of eight groundwater wells (nine wells during the first round) to monitor for any potential off-site migration of contaminants of concern (COCs) and to verify that elevated concentrations of COCs decrease over time. Three of the eight wells will be newly installed 2-inch diameter wells with 10-foot screens for which installation requirements are provided in Section 6.0. Groundwater will be initially monitored for arsenic, iron, manganese, volatile petroleum hydrocarbons (VPH), extractable petroleum hydrocarbons (EPH) and bis(2-ethylhexyl)phthalate (BEHP). For the first year, sampling will be performed in the spring (April/May) and once in the fall (October/November). The first year data will be reviewed and recommendations made in an annual report regarding future sampling frequency, monitoring locations, and analyses for the subsequent year(s).

Institutional controls will also be implemented at AOC 69W to limit the potential exposure to the contaminated soil and groundwater under future site conditions. These institutional controls will ensure

that exposure to remaining contaminated soils beneath and adjacent to the building are controlled and the extraction of groundwater from the site for industrial and/or potable water supply is prohibited. The institutional controls for AOC 69W will be incorporated either in full or by reference into all deeds, easements, mortgages, leases or any other instruments of transfer as part of the transfer of the property. Institutional control monitoring in the form of property owner interviews and onsite inspections will be performed as part of this LTMP. Inspections will be performed at the same frequency as the groundwater monitoring but in no instances less than once every year.

Overall control and supervision of the groundwater monitoring and institutional control inspections at AOC 69W will be the responsibility of the Army. An annual report of the inspections and sampling will be provided to the United States Environmental Protection Agency (USEPA) and the Massachusetts Department of Environmental Protection (MADEP). Monitoring results will be reviewed every five years by the USEPA and will be assessed as to whether the implemented "Limited Action" alternative remains protective of human health or whether the implementation of additional remedial actions is appropriate.

1.0 BACKGROUND

1.1 INTRODUCTION

This Long Term Monitoring Plan (LTMP) describes the site monitoring to be performed at Area of Contamination (AOC) 69W. This monitoring will allow for decisions to be made regarding the effectiveness of the implemented remedy at AOC 69W as required by the Record of Decision (ROD).

The ROD specifies that the following key components be included in the selected remedy at AOC 69W:

- Institutional controls, including deed and/or use restrictions, are established and enforced that restrict or prevent potential human exposure to site soil and ground water contaminants left in place.
- A Long Term Groundwater Monitoring Plan is developed to monitor for any potential off-site migration of contaminants and to verify that elevated concentrations decrease over time.
- Five-year reviews are conducted to review the data collected and to assess the effectiveness of the remedy.

A monitoring program will be initiated to sample and test the groundwater, and to evaluate site conditions to verify that institutional controls are not being infracted. This LTMP details the requirements of this program. Overall control and supervision of the monitoring program shall be the responsibility of the Army. Monitoring results will be reviewed every five years and will be assessed as to whether the implemented "Limited Action" alternative remains protective of human health or whether the implementation of additional remedial actions is appropriate.

1.2 SITE DESCRIPTION AND HISTORY

AOC 69W is located at the northeast corner of the intersection of MacArthur Avenue and Antietam Street on the northern portion of what was formerly the Main Post at Fort Devens (Figure 1-1). AOC 69W is comprised of the former Fort Devens Elementary School (Building 215) and the associated parking lot and adjacent lawn extending approximately 300 feet northwest to Willow Brook. The area is located within an area planned for transfer to Mass Development. The former school is expected to be re-opened in the future.

Contamination at AOC 69W is attributed to heating oil which leaked from underground piping in two separate incidences; once in 1972 and again in 1978. It is estimated that approximately 7,000 to 8,000 gallons of fuel oil were released into soil from each release. The following items summarize the history of AOC 69W.

- **1951**. The Fort Devens Elementary School was built and was comprised of the east/southeast half of the present school. The school was heated by an oil-fired boiler, and the heating oil was stored in a 10,000-gallon UST located in what is currently the school courtyard. The school was operated and maintained by the Ayer School Department.

- **1972**. An addition to the school was built which formed the current school structure. Although a new boiler room was constructed, the old boiler room remained operational. The original 10,000-gallon UST was removed and a new 10,000-gallon UST was installed north of the school in the middle of the current parking lot. During the UST installation, the underground fuel line leading to the new boiler room was accidentally crimped, causing the pipe to split and leak approximately 7,000 to 8,000-gallons of No. 2 fuel oil to the ground.

- **1972-1973**. As a result of the fuel release, an oil recovery system was installed in the vicinity of the 10,000-gallon UST. The system consisted of underground piping connected to a buried 250-gallon concrete vault that acted as an oil/water separator (Figure 2-1). The vault collected oily water and was pumped out approximately every three months.

- **1978**. Underground fuel piping near the old boiler room failed at a pipe joint. Approximately 7,000 to 8,000-gallons of oil were released into the soil during the incident. Soil was excavated to locate the source of the release. The excavation was used to collect the residual oil for one month before the damaged piping was found and replaced. A minimum of 2,600-gallons of residual oil was pumped from the oil recovery system.

- **1989**. On December 21, Fort Devens was placed on the National Priorities List under the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) as amended by the Superfund Amendments and Reauthorization Act (SARA) to evaluate and implement response actions to cleanup past releases of hazardous substances, pollutants, and contaminants. A Federal Facility Agreement to establish a procedural framework for ensuring that appropriate response actions are implemented at Fort Devens was developed and signed by the Army and the U.S. Environmental Protection Agency (USEPA) Region I on May 13, 1991, and finalized on November 15, 1991. AOC 69W is considered a subsite of the entire installation.

- **1993**. The Ayer School Department closed the school because the facility was excess to its needs. As part of the Base Closure process the Army conducted a basewide evaluation of past spill sites and designated the elementary school spill site as Area Requiring Environmental Evaluation (AREE) 69W. Based on document reviews and site visits, the evaluation concluded that residual fuel contamination may have been present in the soil and groundwater at the site.

- **1994**. The Army performed a Site Investigation (SI) which revealed the presence of fuel-related contaminants in both soil and groundwater between the school and the existing fuel UST, and in an area extending northwest from the existing fuel UST to near Willow Brook. The Army redesignated the site as AOC 69W and proposed that a remedial investigation (RI) be performed.

- **1995-1998**. An RI was conducted to define the distribution of contaminants previously detected in the soil and groundwater during the AREE SI, and to determine whether remediation is warranted. Investigation activities included an historical record search and personnel interviews; a geophysical survey and test pitting; sediment and toxicity sampling in Willow Brook; surface and subsurface soil sampling; groundwater monitoring well installation; groundwater sampling and groundwater level measurements; aquifer testing; ecological survey and wetland delineation; air quality sampling within the elementary school; and human health and ecological risk

assessments (Figure 1-2). The RI data showed that fuel-related compounds, primarily total petroleum hydrocarbons (TPHC) and semivolatile organic compounds (SVOCs), were present in soils extending from the new (1972) boiler room to approximately 300 feet northwest. Fuel-related volatile organic compounds (VOCs), SVOCs, TPHC, and inorganics comprised the observed groundwater contaminants. Soil and groundwater contamination appeared to be largely a result of the 1972 fuel oil release. The underground oil recovery system apparently acted as a conduit for contaminant migration in soil and groundwater. Observed contamination from the 1978 release did not appear to be migrating downgradient and further migration is unlikely considering the age of the release and the paved parking lot that inhibits precipitation infiltration.

- **1997-1998**. Based on a review of the soil and groundwater contaminant data, the Army performed a Removal Action and excavated approximately 3,500 cubic yards of petroleum-contaminated soil associated with the 1972 fuel oil leak (Figure 1-2). The 10,000-gallon fuel oil UST and the oil recovery system's 250-gallon vault and associated piping were also removed. The 10,000-gallon fuel oil UST was confirmed to be intact (i.e., no holes or leaks were observed). Confirmatory soil sampling in excavated areas next to the building indicated that extractable petroleum hydrocarbons (EPH) and volatile petroleum hydrocarbons (VPH) concentrations immediately adjacent to the school still exceeded the Massachusetts Contingency Plan (MCP) Method 1 S-1/ GW-1 soil standards after the Removal Action. Due to the proximity of the school, this soil could not be excavated without potential structural damage to the building. Because the area is paved, there is minimal potential for further migration of contaminants and future exposure. Based on the results of the RI and Removal Action, the Army, along with the USEPA and MADEP, concluded that under current conditions and uses, including re-use as a school, AOC 69W did not present unacceptable risks to human health or the environment and that a feasibility study to evaluate remedial action alternatives was not needed.

- **1999**. The Proposed Plan and ROD detailing the Army's plan for Limited Action at AOC 69W ROD was issued.

2.0 GROUNDWATER MONITORING PLAN

2.1 General

The objectives of the groundwater monitoring program are to monitor groundwater for any potential off-site migration of contaminants and to verify that elevated concentrations of the contaminants of concern (COCs) decrease over time.

Risks associated with hypothetical future potable use (worst-case) exposure to AOC 69W groundwater, exceed levels considered acceptable by USEPA due largely to elevated concentrations of arsenic. The arsenic is not directly attributed to the contaminant release but is due to the petroleum contamination causing reducing conditions in the aquifer which liberates the naturally occurring arsenic into groundwater. The soil removal performed in 1997-1998 will act to lessen reducing conditions in the groundwater and therefore arsenic concentrations are expected to continue to decrease. The Army will monitor the groundwater for site contaminants and observe groundwater conditions over time. This plan identifies new and existing groundwater monitoring wells to be sampled, the sampling frequency and the analytical parameters to be evaluated.

2.2 Hydrogeologic Conditions

Evaluations and interpretations of hydrogelogic conditions at AOC 69W from the RI Report (HLA, 1998) are summarized in the following paragraphs.

The water table aquifer at AOC 69W occurs in the overburden at depths ranging from 4 to 8 feet bgs on the north side of the school building to approximately 1-foot bgs adjacent to Willow Brook. Groundwater flow directions are predominately south-southeast to north-northwest as depicted in Figure 2-1. Groundwater discharges to Willow Brook at times of high groundwater levels. Due to surface water runoff and stormwater system discharges, water levels in Willow Brook may be higher than groundwater levels following precipitation events. Vertical gradients have not been calculated as there are no deep overburden wells at the site; however, the intermittent discharge to Willow Brook indicates locally upward gradients exist. Calculated groundwater flow velocities are consistent with the observed sandy soils with a maximum calculated flow velocity of 2 feet/day and a mean flow velocity of 0.7 feet/day.

AOC 69W is located within the delineated Zone 2 for the MacPherson production well located approximately 3,000 feet to the north.

2.3 Monitoring Well Selection

Groundwater monitoring well locations were selected to provide representative samples from source area and downgradient groundwater at AOC 69W based on review of historical analytical results and interpretive water table elevation contours. Well locations were selected to be representative of source area sampling locations used in the risk assessment. They were also selected to monitor groundwater as it leaves the source area, prior to it entering the wetland area associated with Willow Brook, and along the western property line of elementary school (Parcel No. 12 of the Gateway II Verbeck Zone). In

addition to select existing wells, three new monitoring wells will be installed at the site to replace wells removed during the soil removal action and as sentry wells to monitor for downgradient migration. Table 2-1 lists the wells selected for monitoring, the screened interval, location at the site, and sampling rationale. Proposed wells are bolded and a rationale for their location is provided. Approximate locations of these new wells are depicted on Figure 2-1. Monitoring well ZWM-96-19X, located within the new boiler room, will be included in the first round of monitoring. If analytical results from ZWM-96-19X do not exceed MCLs, this well will be excluded from future sampling rounds. Appendix A presents monitoring well construction diagrams for the existing wells. Figures in Appendix B present the RI analytical data for the monitoring wells at AOC 69W for reference. Section 6.0 serves as the work plan detailing the installation of the three new monitoring wells.

2.4 SAMPLING FREQUENCY

For the first year of sampling, groundwater samples will be collected semi-annually from the wells listed in Table 2-1. Sampling will be performed in the spring (April/May) and once in the fall (October/November). The first year data will be reviewed and recommendations made in the annual report regarding sampling frequency, monitoring locations, and analyses for the subsequent year(s). The annual report will be submitted to the regulatory agencies for review and approval. Subsequent annual reports will follow the same process.

2.5 ANALYTES

Wells listed in Table 2-1 will be sampled and analyzed for the constituents listed in Table 2-2. This listing is consistent with the Record of Decision and includes COCs that contributed greater than or equal to a hazard quotient (HQ) of 1.0 in the child resident (and adult resident) RME scenario. These included arsenic (HQ=40), iron (HQ=5.5), manganese (HQ=7.2), bis(2-ethylhexyl)phthalate (BEHP) (HQ=1.6) and VPH C9-C-10 aromatics (HQ=1.3). Arsenic was the only compound that also contributed a carcinogenic risk greater than 1×10^{-4}.

Although BEHP was carried through as a COC for the risk assessment, it was also detected within laboratory method blanks and is suspected of being a laboratory artifact. BEHP will be analyzed within the first round of long term monitoring only within the select wells where the compound was previously detected (1996 groundwater sampling round) above drinking water standards to assess whether this compound is site related or sampling/laboratory artifact.

VPH and EPH analyses for carbon fractions only will also be performed to observe for a reduction in fuel related compounds over time. All analyses will be performed by a laboratory certified by the U.S. Army Corps of Engineers. Laboratory methods are specified in Table 2-2.

Figure 2-2 provides a summary of VPH, EPH, VOCs, and SVOCs concentrations (1997 sampling round) and arsenic, iron, manganese, and BEHP (1996 sampling round). Analytes and concentrations shown in bold exceed drinking water or MCP GW-1/GW-2 standards or other action level such as background concentrations. Action levels for assessment of off-site migration of COCs are presented in Table 2-3 and discussed further in Subsection 4.2, Assessment of Monitoring and Site Inspection Data.

The analyte list and methodologies will be reviewed annually and recommendations for any changes in the analytical program for subsequent sampling rounds will be made in the annual report for review and approval by the regulatory agencies.

2.6 PRE-SAMPLING ACTIVITIES

Once a contract laboratory is selected, the reporting limits and quality control limits, including accuracy, precision, standard recovery, and/or control sample recovery, shall be submitted to the USACE-NAE for approval for each target analyte. Accuracy is defined as the degree to which the analytical measurement reflects the true concentration present. Precision is defined as the agreement among individual measurements of the same chemical constituent in a sample, obtained under similar conditions.

The laboratory will then be contacted approximately two weeks prior to commencement of sampling. Arrangements will be made with the laboratory to prepare and deliver sample containers, caps and labels to a specified location.

2.6.1 Equipment

Equipment required for sampling of the monitoring wells, is as follows:

sample containers, caps and labels
sample preservatives
coolers, ice, and packing
bladder pump/polyethylene tubing
compressed gas (nitrogen)
flow-through cell
500 ml graduated cylinder
0.45 micron in-line filters
personal protective equipment
photoionization detector
water level indicator
pH meter
turbidity meter
conductivity meter
temperature meter
oxidation-reduction potential (ORP) meter
dissolved oxygen (DO) meter
deionized water
decontamination supplies
graduated purge water container (5 gallon bucket)
6-foot rule
well keys
chain-of-custody forms
field data record - groundwater sampling form

field log book

2.6.2 Site Location, Security and Access

Monitoring well locations are shown on Figure 2-1. The wells are located within the school yard and downgradient toward Willow Brook. Wells are not currently within a secured area. However, if the property is transferred from the Army, arrangements will be made through the new property owner to ensure sampling is performed at a time that is least disruptive to property activity (i.e., non-school or after-school hours).

2.7 SAMPLING PROCEDURES

The monitoring wells to be sampled are listed in Table 2-1. Each well will be sampled according to the procedures detailed in the following paragraphs. Monitoring wells will be sampled using low-flow collection procedures in accordance with USEPA Region I Low-Flow Sampling Procedures (USEPA, 1996) attached as Appendix C. These procedures emphasize the need to minimize stress to the aquifer through low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. Appendix D provides a checklist of the general sampling procedures to be followed. All data required by the USEPA Low Flow Sampling Protocol (Appendix C) will be recorded on the data form provided in Appendix E.

2.7.1 Equipment Calibration

Prior to sampling, all monitoring equipment will be calibrated in accordance with manufacture's recommendations. Calibration shall also be checked periodically during the day in the event that readings exceed calibration range or there are unusual readings. Calibration will be rechecked at the end of the sampling event. Results of daily calibrations will be recorded on calibration log sheets.

2.7.2 Initial Well Opening

Upon removing the locking cap and the well casing protective cap, any odors noted will be recorded in the field data record groundwater sampling form. The headspace of the well casings will be checked for VOCs using a PID immediately upon removing the well cover and readings will be recorded on the groundwater sampling form. Any well damage or evidence of tampering will be noted on the groundwater sampling form and described in the field log book.

2.7.3 Water Level Measurements

Prior to purging or sampling from any of the wells at the site, groundwater measurements will be made using an electronic water level indicator. Water level measurements will be taken from all wells on the same day and will be collected from the wells to be sampled plus any non-sampled exterior monitoring wells, piezometers and the new staff gage in Willow Brook. Water levels will be recorded within groundwater monitoring wells from the top of the PVC well casing and will be recorded to the nearest 0.01 foot. The probe will be rinsed with approved decontamination water between sample points. The depth to water will be measured in each well taking care not to lower the probe below the water surface

any further than necessary. Depth to water will be determined with as little physical disturbance of the water in the wells as possible. Water level measurements will be recorded on the groundwater sampling form.

All new groundwater monitoring wells and staff gage will be surveyed for horizontal and vertical location. Groundwater elevations will be measured to verify the groundwater flow direction. Groundwater flow at AOC 69W will be evaluated annually, based upon the groundwater elevation data. Any noticeable changes in groundwater flow will be reported in the annual report. If significant changes in groundwater flow direction are identified, the LTMP for AOC 69W will be re-evaluated.

2.7.4 Well Purging

Prior to sampling, each well will be purged in accordance with the USEPA's Low-Flow Sampling Protocol (Appendix C). This will be done to remove stagnant well water so that a representative sample can be obtained at near ambient flow conditions. Monitoring wells will be purged using an adjustable rate, low flow submersible pump. Tubing will be teflon, teflon lined, PVC or polyethylene. Only teflon lined tubing will be reused and will be decontaminated between sample points. If polyethylene or PVC tubing is used, it will be new or dedicated to the well.

The intake of the pump will be lowered down to the middle of the screened interval (e.g. 5 feet below the top of a 10 foot screen). If the water level is below the top of the screen, the pump intake will be positioned to a depth between the top of the water level and the bottom of the screen. Water will be purged at a rate less than 1 liter/min (i.e., 0.1 to 0.4 liter/min). Water drawdown should ideally not exceed 0.3 feet. However if recharge rates were insufficient to meet this criteria then one volume greater than the stabilized drawdown volume plus the extraction tubing volume will be purged. A water quality meter, equipped with a flow-through cell will be used to measure pH, specific conductance, dissolved oxygen (DO), oxidation-reduction potential (ORP) and temperature. A turbidity meter (not connected to the flow-through cell) will be used to measure turbidity prior to the groundwater entering the flow-through cell.

These water quality parameters will be collected every three to five minutes until stabilized. Stabilization is achieved when three successive readings for each parameter meets the following criteria: pH is +/- 0.1 units; specific conductance is +/-3%, temperature is +/- 3%; ORP is +/- 10 millivolts; and turbidity is +/- 10% for values greater than 1 nephelometric turbidity unit (NTU). One objective of the low-flow sampling is to achieve low turbidity. If all of the water quality parameters have stabilized but the turbidity is too high (i.e., greater than 5 NTUs, the pump flow rate will be decreased and parameter measurements recorded every three to five minutes. If the pumping rate can not be decreased any further and stabilized turbidity values remain above the 5 NTU goal, then the sample will be collected. All water quality parameter readings will be recorded on the groundwater sampling form along with the time the sample was taken.

If the recharge rate of the well is lower than the minimum flow rate capability of the pump, the monitoring well will be pumped dry. The well will be allowed to recharge then the sample will be collected. In this case, samples will be collected even if the groundwater parameters have not stabilized.

2.7.5 Sample Containers and Preservatives

Sample containers will be obtained from the laboratory and shall not be reused. Samples for VPH analyses will be collected in 40 ml amber glass vials with teflon septa. Samples for EPH or SVOC analyses will be collected in 1-liter amber glass jars with teflon lids. Samples for inorganic analyses will be collected in 1-liter polyethylene containers with teflon lids.

If preservatives are added by laboratory personnel they will be marked accordingly. Otherwise, preservatives will be put into the sample bottles by field personnel in accordance with Appendix C. Samples will be kept on ice and delivered to the laboratory within 24 hours of sample collection. The laboratory will re-check the pH prior to analysis to ensure proper preservation was maintained.

The hold time between sample collection and initiation of laboratory analyses will be determined by the specific test analysis and applicable EPA reference. Any analysis of samples after the prescribed holding time should be considered invalid.

2.7.6 Sample Collection

After purging the monitoring well, groundwater samples will be collected for the parameters listed in Table 2-2. Wells will be sampled from the least to the most contaminated based on previous off-site laboratory analyses results to minimize any chance of cross contamination. Samples will be collected directly from the tubing connected to the pump, bypassing the flow-through cell used to monitor water quality parameters. Sample containers will be filled by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence. Sample collection will be performed in accordance with Appendix C.

2.7.7 Sample Identification

Sample identification will be entered on sample identification labels using indelible ink. Labels will be securely attached to the sample container and protected by wrapping with clear plastic tape. Information to be entered on each tag includes:

- Well number
- Sample identification number
- Date
- Time
- Name of person collecting the sample
- Analysis to be performed
- Preservative
- Designation if Matrix Spike/Matrix Spike Duplicate (MS/MSD), Equipment Blank, or Trip Blank, if applicable

2.7.8 Quality Assurance/Quality Control Samples

Duplicate samples, equipment blanks and MS/MSD samples will be collected in accordance with the Project Operations Plan (POP) (ABB-ES, 1995) and USEPA low-flow protocol (Appendix C).

2.7.8.1 Duplicate Sample

The duplicate sample shall be taken immediately following the collection of the regular sample from that well. The duplicate sample shall be prepared in the same way as the regular sample. The well from which the duplicate sample is obtained shall be that well which produced the sample with the highest concentration from the previous sampling event.

2.7.8.2 Equipment Blank

An equipment blank will be collected during each sampling round to check for potential contamination due to sample equipment construction or improper decontamination procedures. An equipment blank shall be collected after sampling one of the more contaminated wells. The equipment blank shall be prepared as follows:

a) The sample pump and associated tubing will be decontaminated in accordance with procedures specified in Appendix C. If tubing is dedicated to the well, the equipment blank will only include the pump used in subsequent sampling.

b) The tubing will be placed into a 1-gallon container of previously unopened deionized water.

c) The pump will be turned on and operated at a low flow rate (0.1 to 0.2 liter/min).

d) Samples will be collected after the deionized water has gone completely through the pump and the tubing. The pump discharge will flow gently down the inside of the sample container with minimal turbulence until the sample container is full.

e) The container shall be labeled as an equipment blank.

Both the duplicate sample and the equipment blank shall be preserved, shipped and analyzed with the other samples from the sampling event.

2.7.8.3 Trip Blank

A trip blank is used to check for potential sample contamination during transport. The trip blank is only analyzed for VOCs and consists of a vial of deionized water, provided by the laboratory, which is put into the cooler with other VOC samples during transport. One trip blank will be collected and added to each cooler being shipped containing samples to be analyzed for VPH.

2.7.8.4 Method Blanks/Surrogate Spike Samples

In addition to the above QA/QC samples, the off-site laboratory will analyze method blank samples and surrogate spike samples. Method blanks are analyzed to maintain internal QA/QC at the off-site laboratory. Surrogate spikes consist of organic compounds that are similar to the analytes of interest in chemical composition, extraction, and chromatography, but which are not normally found in environmental samples. These compounds are spiked into all blanks, standards, and samples prior to analysis. One MS/MSD sample will be collected for each analyses per round.

2.7.8.5 QA Laboratory Samples

An element of the USACE program outlined in EM 200-1-3 and ER-1110-1-263 is the use of a QA laboratory. Splits of ten percent of the samples collected will be sent to the USACE designated QA laboratory. This laboratory will analyze the samples independent of the project's off-site laboratory.

2.7.9 Shipping

Sample containers will be securely packed in insulated coolers containing ice and bubble-wrap packing material. All coolers will be sealed with custody seals and will be accompanied by a chain of custody form. Shipment to the laboratory will be in a manner that ensures timely receipt and maintenance of appropriate sample preservation conditions. Samples shall be logged in at the laboratory no later than 24 hours after collection from the well.

2.7.10 Chain of Custody

The purpose of chain of custody (COC) procedures is to document the identity of the sample and its handling from collection until analysis and data reduction are completed. Custody records trace a sample form its collection through all transfers of custody until it is received by the analytical laboratory. Internal laboratory records then document the custody of the sample through its final disposition.

Adherence to COC procedures is required for all sampling events. A sample is considered to be under a person's custody if it is in a person's physical possession, in view of the person after taking possession, and secured by that person so that no one can tamper with it, or secured by that person in an area that is restricted to authorized personnel. As few individuals as possible will handle each sample to reduce the possibility of error, confusion and/or damage.

After labeling, COC seals shall be filled out by the sampling team and placed on the sample cooler in a manner that would require breaking the seals in order to open the cooler.

A COC will be secured in the cooler to document sample transfer from the sampling team to the laboratory.

2.8 DATA VALIDATION

Data evaluation for this project will be consistent with EPA/540/G-87/003 guidance for acceptable criteria former Level III data collection (current Definitive Data) and will not be accompanied by CLP-type validation normally associated with Level IV data collection activities. For each type of chemical analysis, data validators will use a Data Review Worksheet to review laboratory analytical data. The data validation for this project will include the following standard USACE items:

a. Review of chain-of-custody documents to verify sample identities,

b. Review of sample log-in documents to verify any potential problems with custody seals, container integrity, sample preservation, labeling, etc.,

c. Review of field rinsate blank data to ascertain any potential problems with container contamination, preservative contamination, sampling equipment contamination, or cross contamination between samples during transport,

d. Review of trip blank data to identify any potential problems with sample container contamination, preservative contamination, laboratory reagent water contamination, or cross contamination between samples during transport,

e. Review of method blank data to determine the presence of any sources of contamination in the analytical process,

f. Review the matrix spike (MS) data to evaluate the potential for matrix effects and as a measure of analytical accuracy. MS recoveries will be compared against laboratory acceptance criteria to determine if they are within or outside of warning and control limits for percent recoveries,

g. Review of MS/MSD data to evaluate sample homogeneity and as a measure of analytical precision. MS/MSD data will be compared to laboratory acceptance criteria for the maximum relative percent deviation (RPD),

h. Review of any blank spike (BS) data (if available) as a measure of analytical accuracy. BS recoveries will be compared against laboratory acceptable criteria to determine if they are within or outside of warning and control limits for percent recoveries,

i. Review of BS and blank spike duplicate (BSD) data (if available) as a measure of analytical precision. BS/BSD data will be compared to laboratory acceptance criteria for the maximum RPD,

j. Review of standard reference material (SRM) or Laboratory Control Sample (LCS) data (if available) as a measure of analytical accuracy. SRM and LCS data will be compared to the certified acceptable ranges of the analytical values,

k. Review of sample and sample duplicate data (if available) as a measure of sample homogeneity and as a measure of analytical precision. Sample and sample duplicate data will be compared against the laboratory acceptance criteria for the maximum RPD,

l. Review of surrogate recovery data to assess extraction efficiency, effectiveness of sample introduction, and possible loss during cleanup activities. Surrogate recoveries will be compared to laboratory acceptance criteria to determine if they are within or outside of acceptable limits, and

m. Review of sample dates, extraction/digestion dates, and analysis dates to determine if maximum holding times were met or exceeded.

The following items would not typically be reviewed under a Definitive Data validation effort: instrument tunes; standard curves; internal standard recoveries; system performance check compound results; continuing calibration results; interelement correction check results; laboratory notebook pages; calculations, etc.

2.9 DISPOSAL OF INVESTIGATIVE DERIVED WASTE

All investigation-derived waste (IDW) (purge and decontamination water) will be tested with a PID using the following headspace procedures:

1. Samples will be placed in glass containers; the container mouth will be covered with aluminum foil and capped.

2. Samples will be allowed to stabilize at a temperature of at least 20 degrees C for at least 45 minutes.

3. The sample container lid will be removed. The foil cover will be pierced with the PID probe to measure the total organic vapor concentration in the sample headspace.

All material with readings exceeding background or for which visual and olfactory observations indicate possible contamination, will be containerized in 55-gallon drums. Drums will be identified with weather-resistant labels and transported to an approved storage/disposal area at Devens. If no contamination is detected, water will be discharged to the local storm sewer.

3.0 INSTITUTIONAL CONTROL MONITORING PLAN

3.1 GENERAL

In addition to the groundwater monitoring program, the LTMP will include visual inspections at the site to confirm that deed and/or use restrictions are being implemented as required to restrict or prevent potential human exposure to soil and ground water contaminants left in place at the site.

Under current conditions, AOC 69W poses no unacceptable risks to human health or the environment. The Removal Action performed by the Army in 1997-1998 has eliminated the majority of the petroleum contaminated soils which would otherwise be a continuing source of contamination. The fuel oil UST, piping, and oil recovery system were also removed. The contaminated soil adjacent to and underneath the school that exceeds the MCP Method 1 S-1/ GW-1 soil standards is below a paved area which minimizes any further migration of contaminants and potential future exposure. Because the soil Removal Action eliminated the majority of source area contaminants, estimated risks and interpretations represent worst-case estimates that are unlikely to be exceeded under future land use conditions. However, the remedial action implemented by the ROD requires the Army to continue monitoring site conditions and places limitations on future use to minimize the potential for future exposures.

Institutional controls will be implemented at AOC 69W to limit the potential exposure to the contaminated soil and groundwater under both existing and future site conditions. These institutional controls will ensure that exposure to remaining contaminated soils beneath and adjacent to the building are controlled and the extraction of groundwater from the site for industrial and/or potable water supply would not be permitted. The institutional controls for AOC 69W will be incorporated either in full or by reference into all deeds, easements, mortgages, leases or any other instruments of transfer.

3.2 INSTITUTIONAL CONTROL INSPECTION

Existing land use and site conditions will be evaluated as part of the Long Term Monitoring Program to ensure that the institutional control requirements are still being met. If the future proposed land use at AOC 69W is inconsistent with these institutional controls, then the site exposure scenarios to human health and the environment will be re-evaluated to ensure that this response action is appropriate. Inspections will be performed at the same frequency as the groundwater monitoring but in no instances less than once every year. Institutional control inspections will include the checklist components described in the following paragraphs.

3.2.1 Interview

The monitoring crew will contact the property owner of the site, its manager or other designee with knowledge of the day-to-day activities of the property to make arrangements for groundwater sampling and to review compliance with the institutional controls. As part of the review, the monitoring crew will inquire regarding:

1. The owner's familiarity regarding institutional controls imposed upon the property and documentation of these controls.
2. Excavations (planned or emergency) that may have extended to soils below 2 feet in depth north of the school within the Excavated Soils Management Area (ESMA) delineated on Figure 3-1; and if excavations did occur, were they performed in accordance with an Excavated Soils Management Plan that defines the precautionary measures to be taken to minimize risk to human health and the environment.
3. Source of public drinking water for the property.
4. Proposed plans for property sale, future redevelopment, construction or demolition activities at the site.

3.2.2 Physical On-Site Inspection

After the monitoring crew has contacted the property owner, groundwater monitoring will be performed as well as a physical on-site inspection of the property to determine compliance with the institutional controls. The physical on-site inspection shall include examination for evidence that:

1. No groundwater extraction wells have been installed on the premises.
2. No penetrations are evident through the pavement within the ESMA.
3. No repaved cut marks exist in the pavement within the ESMA that have not otherwise been identified and properly documented by the property owner.

4.0 EVALUATION OF ALTERNATIVE PERFORMANCE

Under CERCLA 121c, any remedial action that results in contaminants remaining on-site must be reviewed at least every five years. During five-year reviews, an assessment is made of whether the implemented remedy is protective of human health and the environment and whether the implementation of additional remedial action is appropriate. The first five-year site review will occur on or before August 2000.

4.1 FIVE-YEAR SITE REVIEWS

The risk assessment conducted for AOC 69W concluded that the risk to human health and the environment was within USEPA risk guidelines under current conditions. Therefore, the five-year site reviews will evaluate the potential migration of contaminant to off-site receptors and to assess for changes in existing land use and site conditions to ensure that institutional control requirements are still being met.

If there is indication that contaminants are migrating downgradient from the former source area, the Army in conjunction with MADEP and USEPA representatives will evaluate the need for additional action. Contaminants will be deemed to be migrating downgradient if any COCs are detected above their respective action levels (Table 2-3) in any of the designated sentry wells (ZWM-95-15X, ZWM-95-18X, ZWM-99-23X, and ZWM-99-24X). The groundwater and brook elevation data will be reviewed to determine if flow direction remains constant and if the monitoring locations continue to be strategically located for detecting off-site migration of COCs. The LTMP will be revised if groundwater flow direction appears to differ from RI interpretations. Similarly, if the future proposed land use at AOC 69W is inconsistent with implemented institutional controls, then the site exposure scenarios to human health and the environment will be re-evaluated to ensure that the response action at AOC 69W is appropriate. More frequent reviews will be performed if site conditions change significantly.

Monitoring will continue until all monitored wells are below action levels for two consecutive sampling rounds and the Army, MADEP, and USEPA agree that the site can be administratively closed out.

4.2 ASSESSMENT OF MONITORING AND SITE INSPECTION DATA

Review of groundwater monitoring and institutional controls site inspection data will take place as part of preparation for the five-year site reviews and will be reported in the Annual Reports.

Groundwater monitoring data will be evaluated to observe for detection of COCs concentrations that exceed action levels at the downgradient sentry wells. Site action levels and rationale for selection of these levels are listed in Table 2-3. Groundwater monitoring data at source area wells will also be evaluated through time to observe trends in contaminant concentrations. It is expected that, once sufficient data are available, the data will be tracked using a linear regression approach. As data accumulate, it may become apparent that other regression analyses or statistical test may become more appropriate for analysis of the distribution of the data. Proposal for the modification of assessment of the

data will be presented in the annual report for review and approval by the regulatory agencies prior to implementing a change.

The results of the institutional control checklist will be assessed and reported in the Annual Report.

5.0 REPORTING REQUIREMENTS

Table 5-1 provides a summary of the proposed sampling/site inspection frequencies and associated deliverables. Frequencies are proposed for a minimum of the first year and may be adjusted upon concurrence of the regulatory agencies based upon sampling and inspection results for the first year. Proposed changes in sampling/inspection and reporting frequency will be recommended in the Annual Report for regulatory review and approval prior to implementation.

5.1 ANNUAL DATA REPORTS

Annual reports will be submitted to the Base Realignment and Closure (BRAC) distribution list which includes USACE-NAE, USEPA, MADEP, and Restoration Advisory Board (RAB) members. The annual data report will include a description of site activities, a summary of the groundwater sampling results, an assessment of the groundwater and brook elevation data, recommendations for future sampling, an assessment for off-site migration and reduction in COC concentrations. It will also include the results of the institutional control inspection and will discuss any corrective action that was necessary as result of changes in site conditions and land use.

5.2 ANALYTICAL REPORTS

All analytical results of groundwater sampling will be submitted, in the form of a "hits only" table and raw data in electronic format, to USEPA and MADEP within 60 days of the sampling date. In the event of an exceedance of an action level (Table 2-3) at a designated sentry well (ZWM-95-15X, ZWM-95-18X, ZWM-99-23X, and ZWM-99-24X), USEPA and MADEP representatives will be notified by memorandum and/or direct telephone contact within 60 days of the sampling event.

6.0 GROUNDWATER MONITORING WELL INSTALLATION WORK PLAN

This section serves as the Work Plan for the proposed installation of the three new groundwater monitoring wells to be installed at AOC 69W Devens, Massachusetts. These wells are to be used in the long term groundwater monitoring program which is being implemented at AOC 69W, in accordance with the Record of Decision signed on June 30, 1999. This work plan describes the rationale for the well locations, the proposed drilling methods, and monitoring well construction. This work plan serves as a supplement to the POP (ABB-ES, 1995). The objective of the work is to fill data gaps in the long term groundwater monitoring well program.

6.1 DOCUMENTATION

Filed activities will be recorded by an on-site HLA Field Operations Leader (FOL) or geologist in a bound logbook and will include the following, as a minimum:

- Project name and job number
- Date and time of field activities
- Observations, including descriptions of geologic units and any waste material encountered, staining (if any), and presence of odors. Drill cuttings will be used to classify geologic units.
- PID headspace readings of drill cuttings
- Health & Safety information (PPE & air monitoring)

HLA will also complete Boring Logs, Well Construction Diagrams, Well Development Records, and Field Instrumentation Calibration Sheets (Figures 4-8A, 4-3, 4-5 and 4-11 in the POP). These forms will be made part of the permanent record of the fieldwork.

6.2 UTILITY CLEARANCES

Utility clearances will be obtained before conducting any intrusive subsurface investigations. Existing utility drawings will be reviewed and “Dig Safe” clearances will be obtained to assure that no underground utilities exist at the proposed locations. If underground utilities are present at the planned well location, the location will be moved.

6.3 DRILLING/WELL INSTALLATION

Three soil borings, completed as monitoring wells, will be installed at the northern side of the former elementary school building (Figure 2-1). Proposed groundwater monitoring well ZWM-99-22X will serve as a replacement well for the former groundwater monitoring well 69W-94-10 which was removed during the 1997-1998 Removal Action. This well, along with the existing source area well 69W—94-13, will be used to monitor for decrease in EPH and inorganic COC concentrations over time. ZWM-99-23X and ZWM-99-24X will be installed downgradient of the paved area towards Willow Brook and will be positioned approximately cross-gradient to 69W-94-14. These two wells will serve as sentry wells to observe for potential off-site migration of EPH compounds and for decrease in arsenic, iron and

manganese concentrations. Based on observed COC concentrations in 69W-94-14, EPH concentrations are anticipated to be close to detection limits in these new sentry wells while manganese concentrations may be close to the manganese action level (375 µg/L) but is expected to decrease with time (Figure 2-2). All three new wells will be water table wells with 10-foot screens that will extend 2 to 3 feet above the water table where depth of unsaturated overburden permits. Table 2-1 provides monitoring well details and summarizes the rationale for selection of their locations.

Borings will be advanced using hollow stem augers. Soil samples will not be collected. Soil will be logged based on visual inspection of drill cuttings. Drill cuttings will be monitored with a PID. All material with observed contamination will be containerized in accordance with the POP (ABB-ES, 1995).

The drill rig and drilling equipment will be steam-cleaned prior to being delivered onsite. Prior to the drilling of each boring all downhole drilling equipment will be steam cleaned. Water required for drilling and decontamination activities will be obtained from the South Post Water Point or other approved source.

Monitoring well installation and construction will be in accordance with the POP. The well material will be 2-inch diameter, Schedule 40 PVC, with flush-threaded joints. Screens will be PVC, 10-foot long, and will have 0.010-inch slot size. A sand pack will be placed around the screen to a height of up to 5 feet above the screen where unsaturated overburden depth permits. (i.e., the sand packs for ZWM-99-23X and ZWM-99-24X, which are close to Willow Brook, may only be able to be placed to a height of approximately 1 foot above the screen). An annular seal, consisting of bentonite pellets will be placed above the sand pack (up to 5 feet, if overburden depth permits). A cement-bentonite grout will extend from the top of the bentonite pellet seal to the ground surface.

Surface completion of wells ZWM-99-23X and ZWM-99-24X will consist of a minimum 4-inch diameter stick-up protective casing with locking cap in accordance with Figure 4-4A of the POP. A course gravel pad, 6-inches thick, extending 4 feet radially from the protective casing will be constructed around each well. Four guard posts will be constructed at the edge of the gravel pad, on approximate 6-foot centers around the wells, and will be filled with cement. Well numbers will be labeled on the side of the protective casing. Well ZWM-99-22X is located within the paved area at the north side of the building and will be completed with a protective road box casing with drain holes and flush mounted water-tight cover in accordance with Figure 4-4B of the POP. All three wells will be surveyed using the same datum used for the existing wells.

6.4 MONITORING WELL DEVELOPMENT

Newly installed wells will be developed using a submersible pump, bailer or other equally effective method in accordance with Section 4.4.6.6 of the POP.

During well development, conductivity, pH, temperature, and turbidity will be monitored. Well development will continue until water is clear to the unaided eye, sediment thickness remaining in the well is less than 1 percent of the screen length; and the total volume of water removed from the well equals at least five well volumes.

6.5 EQUIPMENT DECONTAMINATION AND DISPOSAL OF INVESTIGATIVE DERIVED WASTE

All downhole equipment will be decontaminated prior to drilling each boring at a temporary centrally located decontamination pad. Details of decontamination procedures are described in the POP. All investigative derived waste (water and soil) will be tested with a PID using headspace procedures. All material with readings above background, or for which visual and olfactory observations indicated possible contamination, will be containerized in 55-gallon drums for analytical testing. Drums will be transported for temporary on-post storage on wooden pallets. If no contamination is detected, uncontaminated cuttings, fluids, and sediments native to the immediate area will be discharged to the local storm sewer.

6.6 FIELD EQUIPMENT OPERATION AND CALIBRATION

All instruments and equipment used during the filed program will be operated, calibrated, and maintained per manufacturer's guidelines. Field equipment will be calibrated at the beginning of each day and periodically throughout the day, if necessary. A calibration check will be performed at the end of each day to check instrument drift.

6.7 HEALTH AND SAFETY

All field activities conducted by HLA will be in compliance with Appendix A Health and Safety Plan of the POP. A designated Site Safety and Health Officer will be responsible for ensuring adherence to all health and safety requirements.

AOC	area of contamination
AREE	Area Requiring Environmental Evaluation
BEHP	bis(2-ethylhexyl)phthalate
bgs	below ground surface
BRAC	Base Realignment and Closure
BS	blank spike
BSD	blank spike duplicate
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CFR	Code of Federal Regulations
CLP	Contract Laboratory Program
COCs	contaminants of concern
DO	dissolved oxygen
EPH	extractable petroleum hydrocarbons
feet/day	feet per day
FS	feasibility study
HQ	hazard quotient
IDW	investigation-derived waste
LCS	Laboratory Control Sample
liter/min	liter per minute
LTMP	Long Term Monitoring Plan
MADEP	Massachusetts Department of Environmental Protection
MCL	maximum contaminant levels
MCP	Massachusetts Contingency Plan
MS	matrix spike
MSD	matrix spike duplicate
µg/l	micrograms per liter
NAE	New England District
NTU	nephelometric turbidity units
ORP	oxidation-reduction potential
OSHA	Occupational Safety and Health Act

PID	photoionization detector
POP	Project Operations Plan
PPE	personal protective equipment
ppm	parts per million
QA/QC	quality assurance and quality control
RAB	Restoration Advisory Board
RFTA	Reserve Forces Training Area
RI	remedial investigation
RME	Reasonable Maximum Exposure
ROD	record of decision
RPD	relative percent deviation
SARA	Superfund Amendments and Reauthorization Act
SI	Site Investigation
SRM	standard reference material
SVOC	semivolatile organic compounds
TPHC	total petroleum hydrocarbons
USACE	U.S. Army Corps of Engineers
USEPA	U.S. Environmental Protection Agency
UST	underground storage tank
VOC	volatile organic compound
VPH	volatile petroleum hydrocarbon

ABB Environmental Services, Inc. (ABB-ES), 1995. "Project Operations Plan, Fort Devens, Massachusetts"; Contract No. DACA31-94-D-0061; prepared for U.S. Army Environmental Center; May.

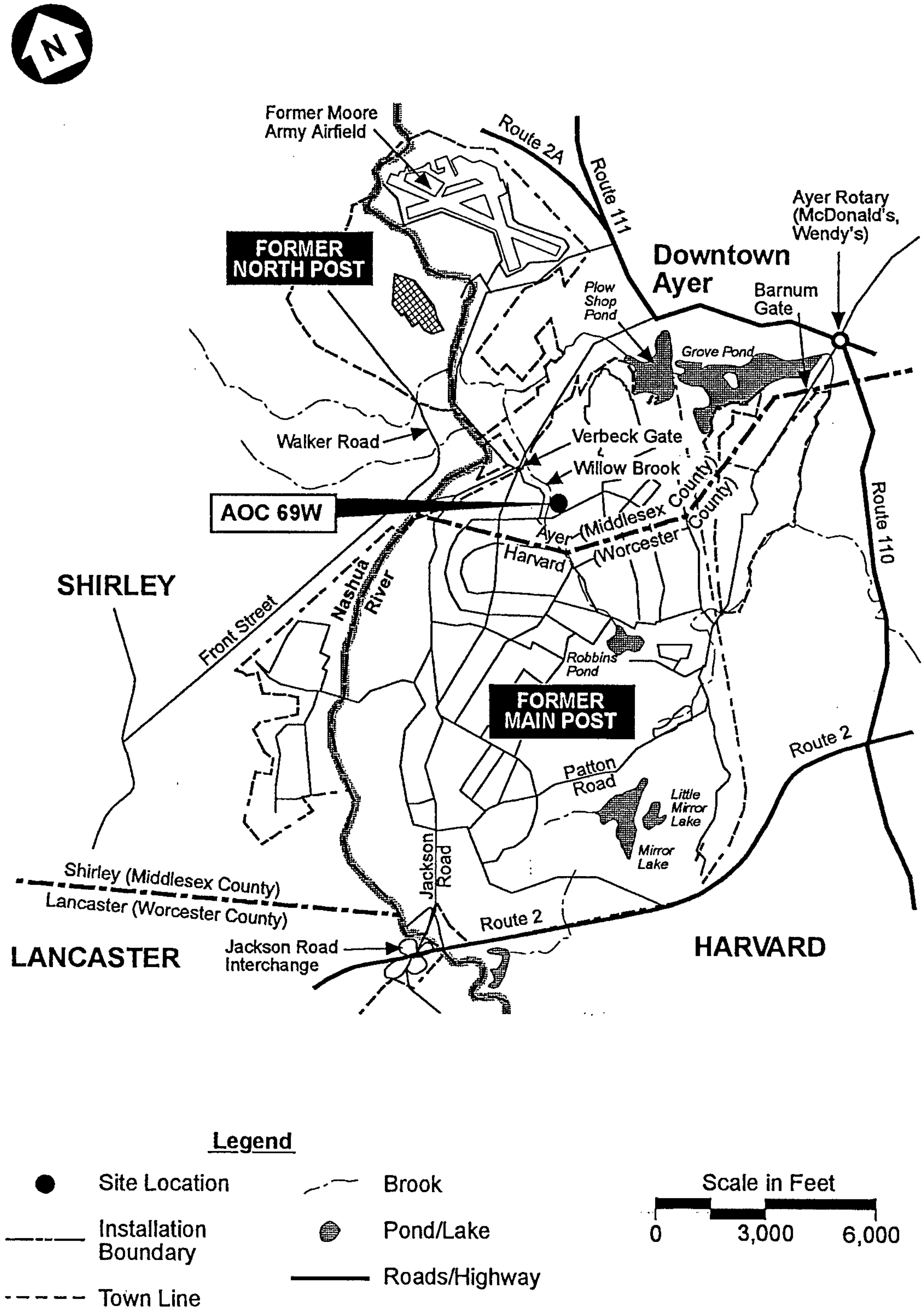
Harding Lawson Associates. (HLA), 1998. Final Remediation Investigation Report, Area of Contamination (AOC) 69W, Devens, Massachusetts; Contract No. DAAA-31-94-D-0061; prepared for U.S. Army Corps of Engineers; August.

Massachusetts Department of Environmental Protection (MADEP), 1996. "Massachusetts Contingency Plan" Office of Environmental Affairs, Boston, Massachusetts, September 9, 1996.

U.S. Army Corps of Engineers (USACE), 1999. "Record of Decision Area of Contamination 69W"; June 1999.

U.S. Environmental Protection Agency (USEPA) Region I, 1988. *Region I Laboratory Data Validation Functional Guidelines for Evaluating Organic Analyses*, November 1988.

U.S. Environmental Protection Agency Region I, 1996. "Low Stress (low flow) Purging and Sampling Procedure for the Collection of Ground Water Samples from Monitoring Wells". SOP #: GW 0001; Revision Number: 2; July 30.

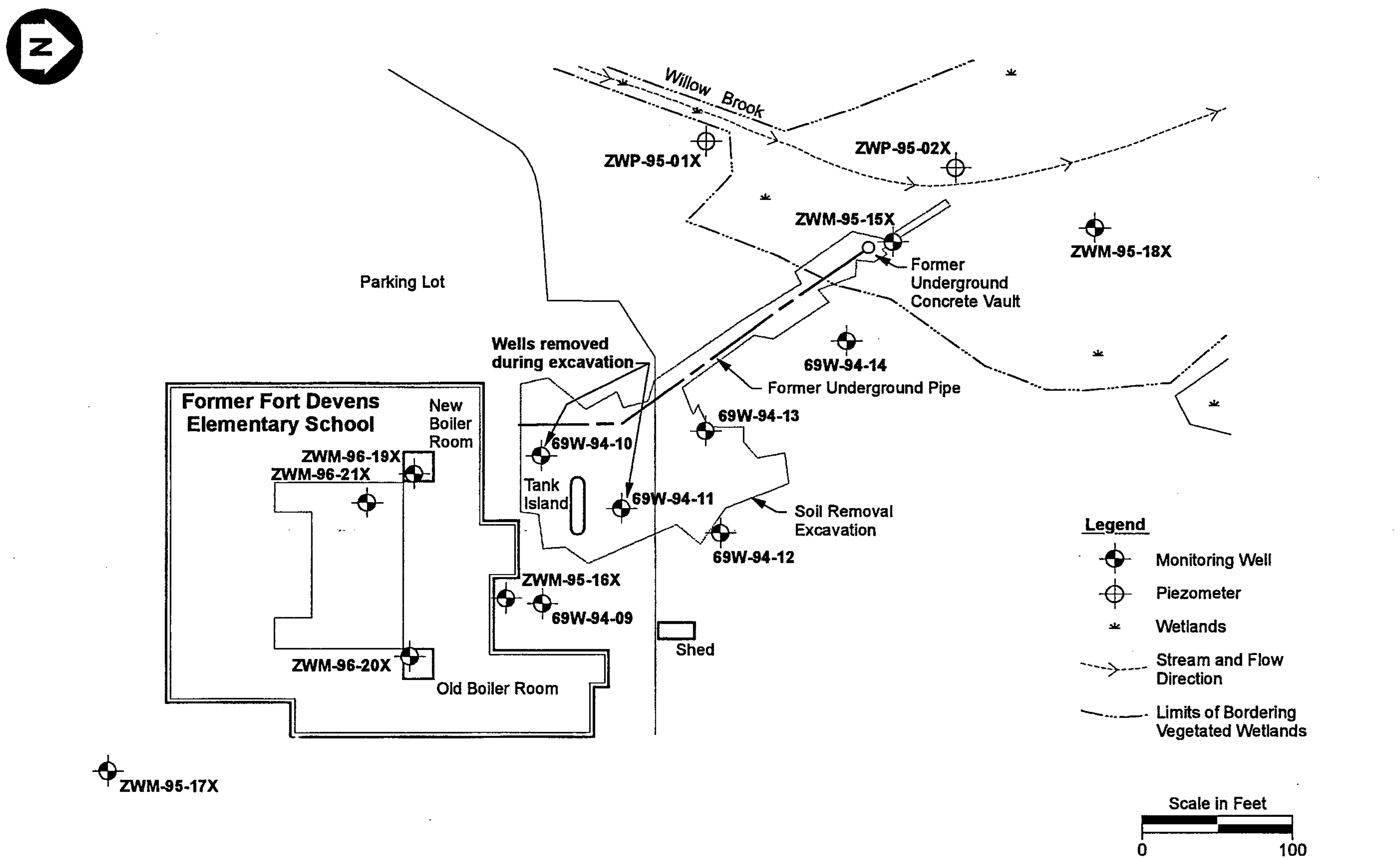


Harding Lawson Associates
Engineering and
Environmental Services

Location of AOC 69W
Long-term Monitoring Plan
Devens, Massachusetts

FIGURE
1-1

DRAWN:	JOB NUMBER:	FILE NUMBER:	APPROVED:	DATE:	REVISED DATE:
bgf	45001	W9906003(a)		6/99	



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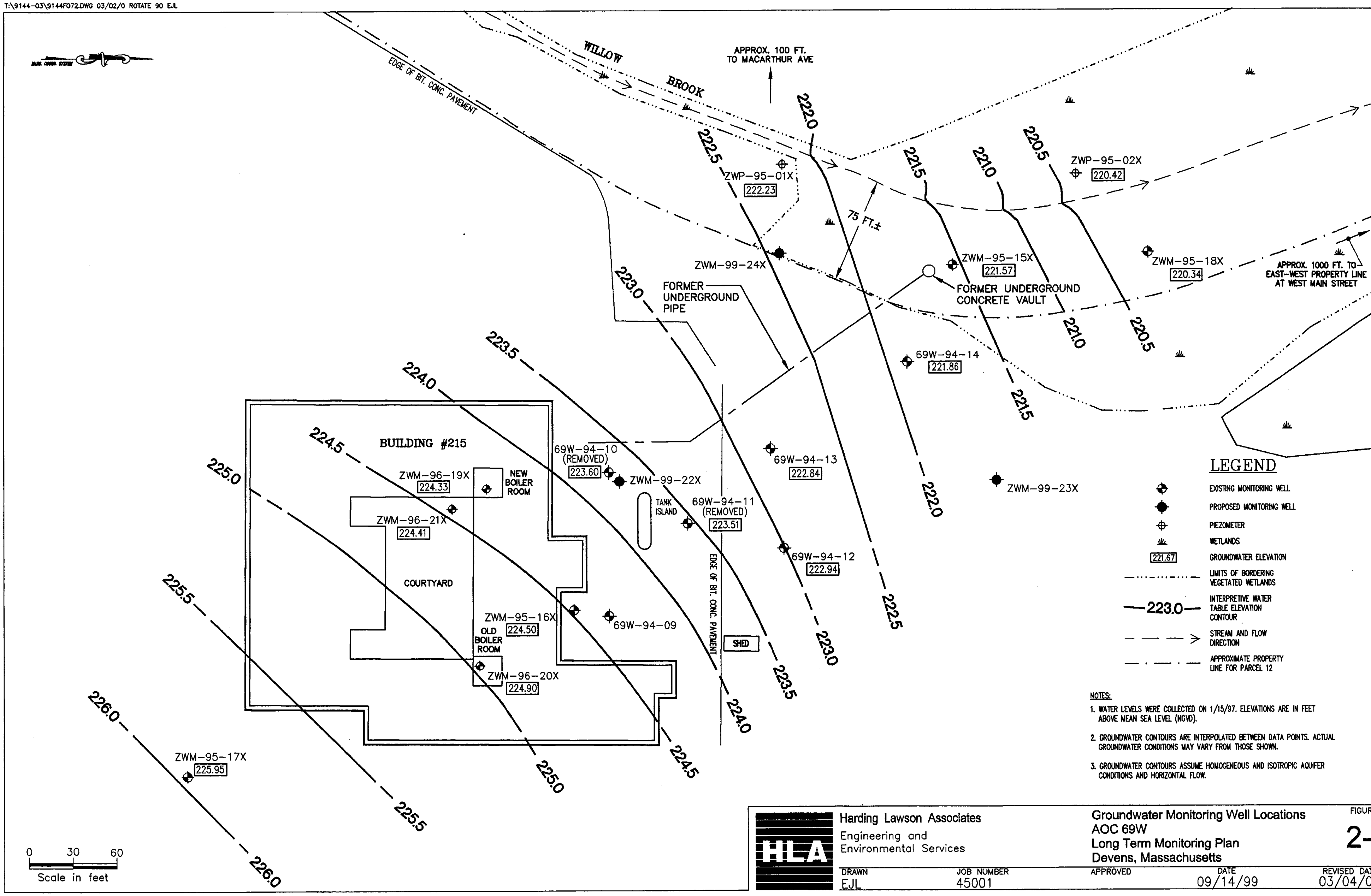
Engineering and
Environmental Services

AOC 69W Site Plan
Long-term Monitoring Plan
Devens, Massachusetts

FIGURE **1-2**

DRAWN:	JOB NUMBER:	FILE NUMBER:	APPROVED:	DATE:	REVISED DATE:
jph	45001	W9906003(b)		6/99	

T:\9144-03\9144F072.DWG 03/02/0 ROTATE 90 EJL



NOTES:

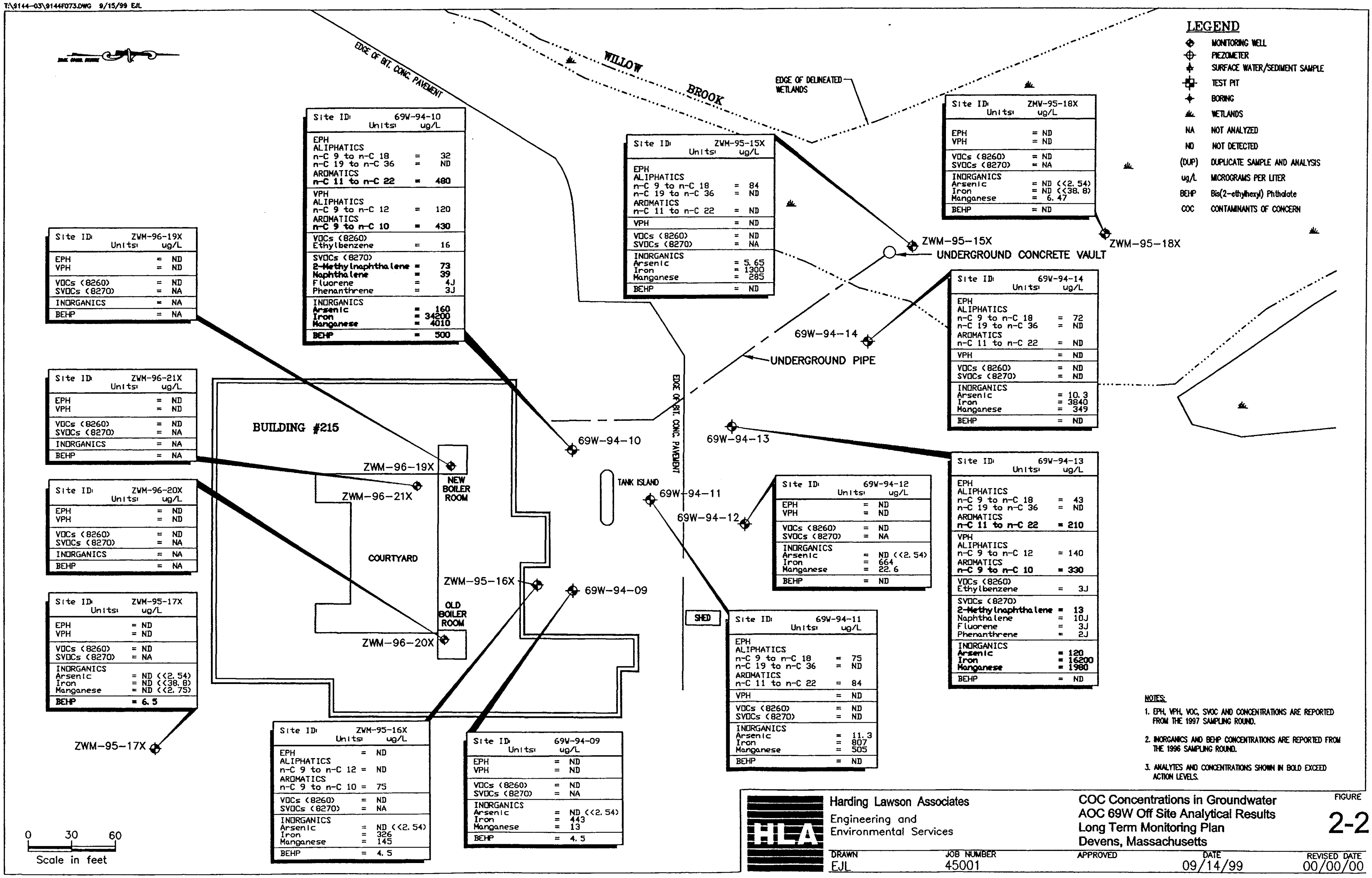
1. WATER LEVELS WERE COLLECTED ON 1/15/97. ELEVATIONS ARE IN FEET ABOVE MEAN SEA LEVEL (NGVD).
2. GROUNDWATER CONTOURS ARE INTERPOLATED BETWEEN DATA POINTS. ACTUAL GROUNDWATER CONDITIONS MAY VARY FROM THOSE SHOWN.
3. GROUNDWATER CONTOURS ASSUME HOMOGENEOUS AND ISOTROPIC AQUIFER CONDITIONS AND HORIZONTAL FLOW.

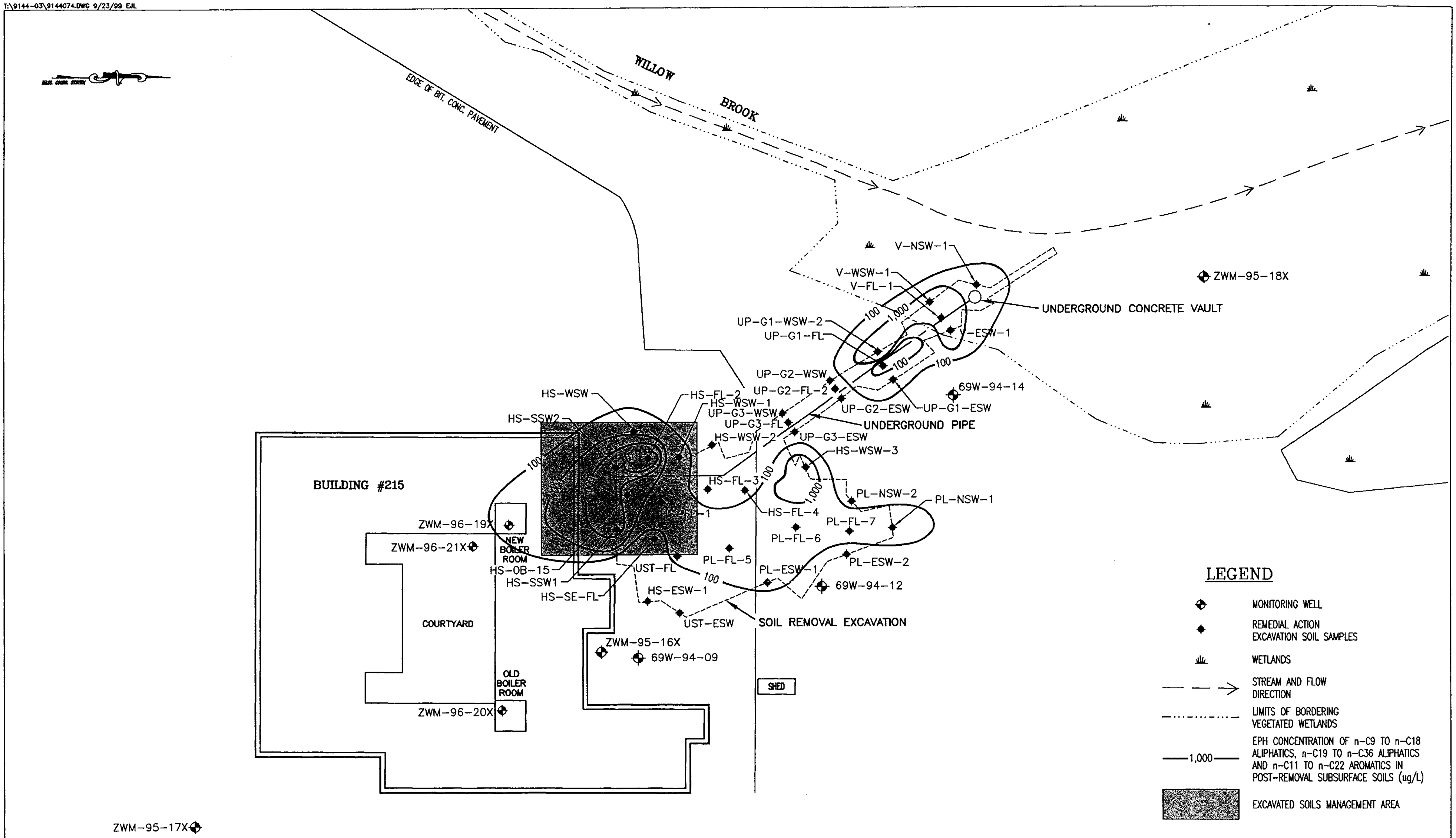
HLA Harding Lawson Associates
Engineering and Environmental Services

Groundwater Monitoring Well Locations
AOC 69W
Long Term Monitoring Plan
Devens, Massachusetts

FIGURE 2-1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
EJL	45001		09/14/99	03/04/00


T:\9144-03\9144F073.DWG 9/15/99 EJL
LEGEND
MONITORING WELL
PIEZOMETER
SURFACE WATER/SEDIMENT SAMPLE
TEST PIT
BORING
WETLANDS
NA NOT ANALYZED
ND NOT DETECTED
(DUP) DUPLICATE SAMPLE AND ANALYSIS
ug/L MICROGRAMS PER LITER
BEHP Bis(2-ethylhexyl) Phthalate
COC CONTAMINANTS OF CONCERN
EDGE OF BIT. CONC. PAVEMENT
WILLOW BROOK
EDGE OF DELINEATED WETLANDS
UNDERGROUND CONCRETE VAULT
UNDERGROUND PIPE
BUILDING #215
COURTYARD
NEW BOILER ROOM
OLD BOILER ROOM
TANK ISLAND
SHED
ZWM-95-15X
ZWM-95-18X
69W-94-14
69W-94-13
69W-94-10
69W-94-11
69W-94-12
69W-94-09
ZWM-95-16X
ZWM-96-19X
ZWM-96-21X
ZWM-96-20X
ZWM-95-17X
Site ID: 69W-94-10 Units: ug/L
EPH ALIPHATICS n-C 9 to n-C 18 = 32
n-C 19 to n-C 36 = ND
AROMATICS n-C 11 to n-C 22 = 480
VPH ALIPHATICS n-C 9 to n-C 12 = 120
AROMATICS n-C 9 to n-C 10 = 430
VOCs (8260) Ethylbenzene = 16
SVOCs (8270) 2-Methylnaphthalene = 73
Naphthalene = 39
Fluorene = 4J
Phenanthrene = 3J
INORGANICS Arsenic = 160
Iron = 34200
Manganese = 4010
BEHP = 500
Site ID: ZWM-95-15X Units: ug/L
EPH ALIPHATICS n-C 9 to n-C 18 = 84
n-C 19 to n-C 36 = ND
AROMATICS n-C 11 to n-C 22 = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS Arsenic = 5.65
Iron = 1300
Manganese = 285
BEHP = ND
Site ID: ZMW-95-18X Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS Arsenic = ND (<2.54)
Iron = ND (<38.8)
Manganese = 6.47
BEHP = ND
Site ID: 69W-94-14 Units: ug/L
EPH ALIPHATICS n-C 9 to n-C 18 = 72
n-C 19 to n-C 36 = ND
AROMATICS n-C 11 to n-C 22 = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = ND
INORGANICS Arsenic = 10.3
Iron = 3840
Manganese = 349
BEHP = ND
Site ID: 69W-94-13 Units: ug/L
EPH ALIPHATICS n-C 9 to n-C 18 = 43
n-C 19 to n-C 36 = ND
AROMATICS n-C 11 to n-C 22 = 210
VPH ALIPHATICS n-C 9 to n-C 12 = 140
AROMATICS n-C 9 to n-C 10 = 330
VOCs (8260) Ethylbenzene = 3J
SVOCs (8270) 2-Methylnaphthalene = 13
Naphthalene = 10J
Fluorene = 3J
Phenanthrene = 2J
INORGANICS Arsenic = 120
Iron = 16200
Manganese = 1980
BEHP = ND
Site ID: 69W-94-12 Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS Arsenic = ND (<2.54)
Iron = 664
Manganese = 22.6
BEHP = ND
Site ID: 69W-94-11 Units: ug/L
EPH ALIPHATICS n-C 9 to n-C 18 = 75
n-C 19 to n-C 36 = ND
AROMATICS n-C 11 to n-C 22 = 84
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = ND
INORGANICS Arsenic = 11.3
Iron = 807
Manganese = 505
BEHP = ND
Site ID: ZWM-96-19X Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS = NA
BEHP = NA
Site ID: ZWM-96-21X Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS = NA
BEHP = NA
Site ID: ZWM-96-20X Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS = NA
BEHP = NA
Site ID: ZWM-95-17X Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS Arsenic = ND (<2.54)
Iron = ND (<38.8)
Manganese = ND (<2.75)
BEHP = 6.5
Site ID: ZWM-95-16X Units: ug/L
EPH = ND
ALIPHATICS n-C 9 to n-C 12 = ND
AROMATICS n-C 9 to n-C 10 = 75
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS Arsenic = ND (<2.54)
Iron = 326
Manganese = 145
BEHP = 4.5
Site ID: 69W-94-09 Units: ug/L
EPH = ND
VPH = ND
VOCs (8260) = ND
SVOCs (8270) = NA
INORGANICS Arsenic = ND (<2.54)
Iron = 443
Manganese = 13
BEHP = 4.5
0 30 60
Scale in feet
NOTES:
1. EPH, VPH, VOC, SVOC AND CONCENTRATIONS ARE REPORTED FROM THE 1997 SAMPLING ROUND.
2. INORGANICS AND BEHP CONCENTRATIONS ARE REPORTED FROM THE 1996 SAMPLING ROUND.
3. ANALYTES AND CONCENTRATIONS SHOWN IN BOLD EXCEED ACTION LEVELS.
HLA
Harding Lawson Associates
Engineering and Environmental Services
COC Concentrations in Groundwater
AOC 69W Off Site Analytical Results
Long Term Monitoring Plan
Devens, Massachusetts
FIGURE 2-2
DRAWN EJL
JOB NUMBER 45001
APPROVED
DATE 09/14/99
REVISED DATE 00/00/00



HLA Harding Lawson Associates
Engineering and Environmental Services

Excavated Soils Management Area
AOC 69W
Long Term Monitoring Plan
Devens, Massachusetts

FIGURE 3-1

DRAWN	JOB NUMBER	APPROVED	DATE	REVISED DATE
EJL	45001		09/23/99	00/00/00

TABLE 2-1
MONITORING WELLS SELECTED FOR LONG TERM MONITORING

AOC 69W LONG TERM MONITORING PLAN
DEVENS, MASSACHUSETTS

MONITORING WELL [1]	SCREENED INTERVAL (FT BGS)	LOCATION	RATIONALE
XWM-95-17X (4" I.D.)	12.2 – 22.2 ft.	Southeast of school	Background (upgradient) well
ZWM-99-22X (2" I.D.)	5 – 15 ft. (est.)	Proposed well in paved source area	Replacement well for former source area well 69W-94-10. Monitor for decrease in COC concentrations.
69W—94-13 (2" I.D.)	4 – 14 ft.	North of paved area near source area	Source area well. Monitor for decrease in COC concentrations.
69W-94-14 (2" I.D.)	3 – 13 ft.	Approx. 30 feet upgradient of Willow Brook wetlands	Monitor for decrease in COC concentrations and decrease in the potential for off-site migration.
ZWM-95-15X (4" I.D.)	3 – 13 ft.	Near former underground concrete vault	Sentry well. Monitor for decrease in COC concentration and decrease in the potential for off-site migration.
ZWM-95-18X (4" I.D.)	3 – 13 ft.	Approximately 120 ft. downgradient of the concrete vault	Sentry well. Monitor for off-site migration.
ZWM-99-23X (2" I.D.)	3 – 13 ft. (est.)	Proposed downgradient well northeast of 69W-94-14	Sentry well. Monitor for decrease in COC concentration and decrease in the potential for off-site migration.
ZWM-99-24X (2" I.D.)	3 – 13 ft. (est.)	Proposed downgradient well east of Willow Brook and southwest of 69W-94-14	Sentry well. Monitor for decrease in COC concentration and decrease in the potential for off-site migration.
ZWM-96-19X[2] (2" I.D.)	6 – 16 ft.	Located within "new" boiler room	Source area well. Monitor for decrease in COC concentration and decrease in the potential for off-site migration.

1 All monitoring wells are water table wells.

2 If all analytes are below MCLs during the first round of sampling, future sampling will be discontinued.

Notes: ft – feet.
bgs – below ground surface.
I.D. – inside diameter
est. – estimated
COC – contaminants of concern.

TABLE 2-2
GROUNDWATER SAMPLE ANALYSIS AND PROCEDURE

AOC 69W LONG TERM MONITORING PLAN
DEVENS, MASSACHUSETTS

ANALYSIS	METHOD NO
EPH	MADEP [1]
VPH	MADEP [2]
Iron & Manganese	USEPA Method 200.7
Arsenic	USEPA Method 206.2
Bis(2-ethylhexyl) Phthalate [3]	USEPA Method 8270 C
Field Parameters	
Ph	Field Measured
Temperature	Field Measured
Specific Conductance	Field Measured
Dissolved Oxygen	Field Measured
Oxidation Reduction Potential	Field Measured
Turbidity	Field Measured

1 MADEP Method for the Determination of Extractable Petroleum Hydrocarbons. Only carbon fractions are to be reported.

2 MADEP Method for the Determination of Volatile Petroleum Hydrocarbons. Only carbon fractions are to be reported.

3 Analyses for bis(2-ethylhexyl)phthalate proposed to assess if previous detections were site-related or a sampling/laboratory artifact. Analyses will be performed in monitoring wells ZWM-99-22X and ZWM-95-17X.

Notes: EPH – extractable petroleum hydrocarbons .
MADEP - Massachusetts Department of Environmental Protection.
USEPA - United States Environmental Protection Agency.
VPH - volatile petroleum hydrocarbons.

TABLE 2-3
ACTION LEVELS

AOC 69W LONG TERM MONITORING PLAN
DEVENS, MASSACHUSETTS

CHEMICAL OF CONCERN	MCP [1] GW-1/GW-2 (μg/L)	BACKGROUND [2] (μg/L)	SMCL (μg/L)	MCL [3] (μg/L)	MMCL [4] (μg/L)	ACTION LEVEL (μg/L)
Arsenic	50	10.5	--	50	50	50
Iron	NA	9,100	300	--	--	[5] 9,100
Manganese	NA	291	50	--	--	[6] 375
VPH						
C5-C8 Aliphatic	400	NA	NA	NA	NA	400
C9-C12 Aliphatic	1,000	NA	NA	NA	NA	1,000
C9-C10 Aromatic	1,000	NA	NA	NA	NA	1,000
EPH						
C9-C18 Aliphatic	1,000	NA	NA	NA	NA	1,000
C19-C36 Aliphatic	5,000	NA	NA	NA	NA	5,000
C11-C22 Aromatic	200	NA	NA	NA	NA	200
Bis(2-ethylhexyl) phthalate	6	NA	NA	6	6	6

1 Massachusetts Contingency Plan (310 CMR 40) GW-1 or GW-2 Standards (whichever is the most conservative [GW-1 or GW-2] is presented).
2 Background concentrations determined from 10 wells at select locations on base. Refer to AOC 69W RI, Appendix K (HLA, 1998).
3 Drinking Water Regulations and Health Advisories", October 1996, USEPA Office of Water.
4 Drinking Water Standards & Guidelines for Chemicals in Massachusetts Drinking Waters", May 1998, Massachusetts Department of Environmental Protection.
5 Background concentration is higher than risk-based concentration for child receptor of 4,693 μg/L (reference dose value of 3.0 E-01).
6 Risk-based concentration based on USEPA Region I reference dose value of 2.4E-02 (risk-based concentration for child receptor is higher than Devens background concentration of 291 μg/L).

Notes:
ND – non detect.
NA – not applicable.
MCL – Maximum Contaminant Level.
SMCL – Secondary MCL based on aesthetics.
MMCL – Massachusetts Maximum Contaminant Level.

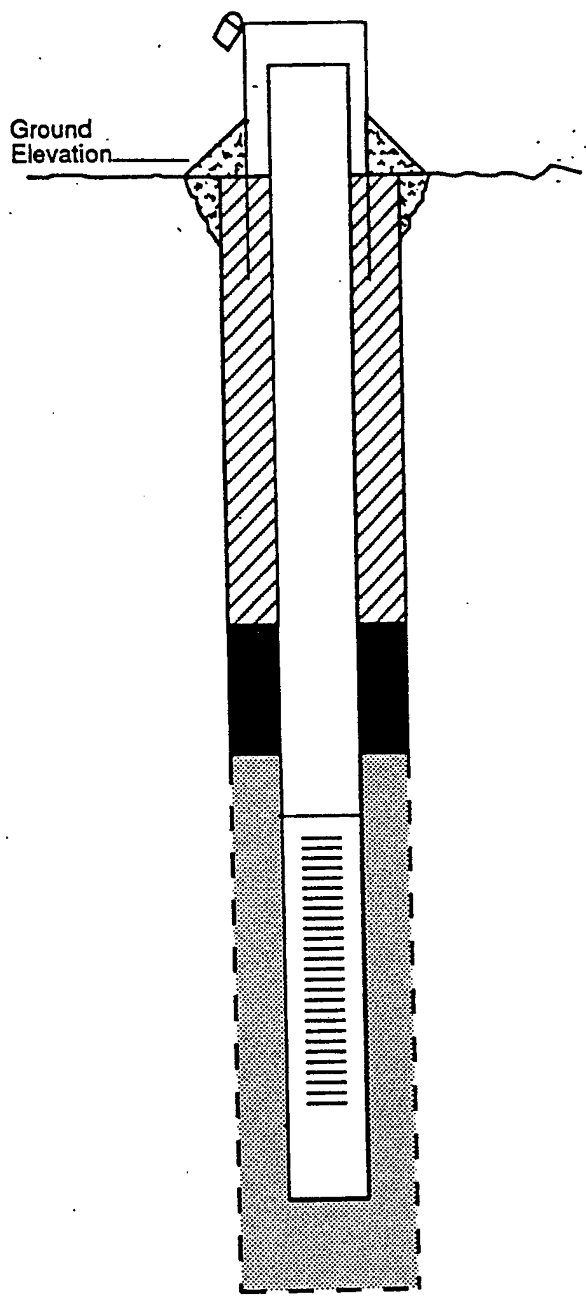
TABLE 5-1
SUMMARY OF SAMPLING AND REPORTING REQUIREMENTS

AOC 69W LONG TERM MONITORING PLAN
DEVENS, MASSACHUSETTS

REPORT/SAMPLE	FREQUENCY
Site Inspection/Groundwater Sampling	Twice/Year [1]
Groundwater Analytical Data to USEPA and MADEP	Within 60 days of sampling
Site Review/Report	Every Five Years
Annual Data Report to USEPA and MADEP	Annual
[1] April/May and October/November.	

MONITORING WELL CONSTRUCTION DIAGRAM

Project Fort Devens
Study Area AOC - 69W
Driller K. REGAN (D.L. MAHER)
Project No. 09144-02
Boring No. ZWM-95-15X
Drilling Method H.S.A.
Date Installed 9/19/95
Development Method
Field Geologist G. GULSETTI



Stick-up of Casing Above Ground Surface: 2.75 FEET

Type of Surface Seal/ Other Protection:

Type of Surface Casing: PROCOVER

ID of Surface Casing: 6 INCH

Diameter of Borehole: 10 INCH

Riser Pipe ID: 4 INCH

Type of Riser Pipe: SCH 40 PVC

Type of Backfill: BENTONITE GROUT

Depth of Top of Seal: 1.0 FOOT (bgs)

Type of Seal: BENTONITE PELLETS

Depth of Top of Sand: 2.0 FEET (bgs)

Depth of Top of Screen: 3.0 FEET (bgs)

Type of Screen: SCH 40 PVC

Slot Size x Length: 0.010 INCH - 10 FEET

ID of Screen: 4 INCH

Type of Sandpack: #00 SAND

Depth of Bottom of Screen: 13.0 FEET

Depth of Sediment Sump with Plug: N/A

Depth of Bottom of Borehole: 13.5 FEET

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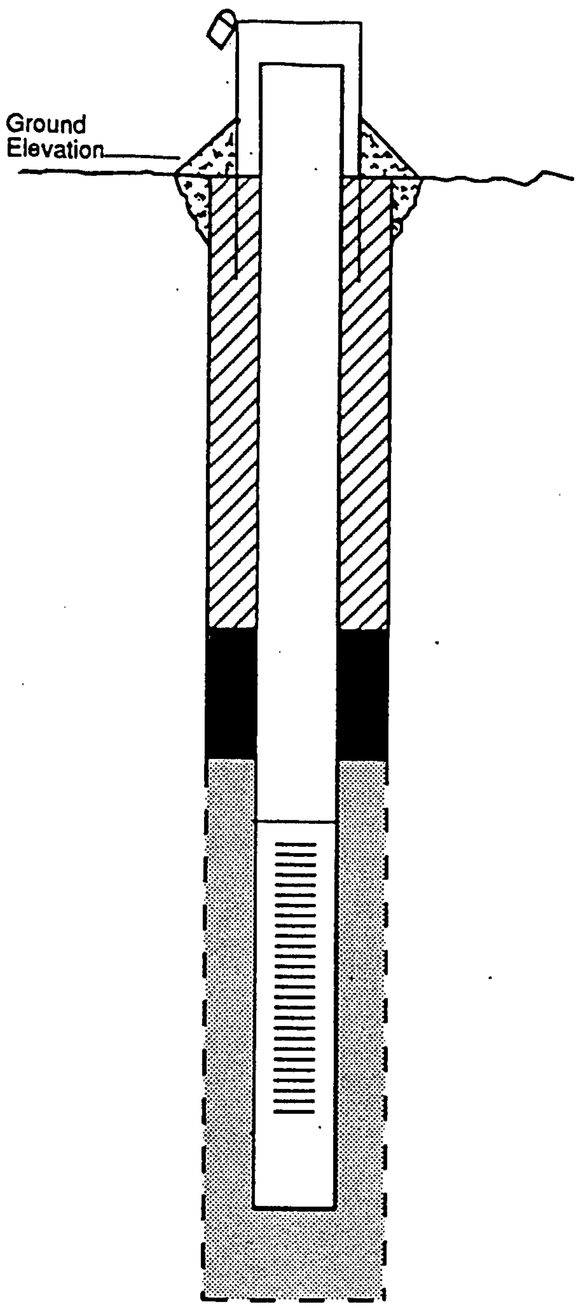
9312005S L16

MONITORING WELL CONSTRUCTION DIAGRAM

Project Fort Devens
Project No. 09144-02
Study Area AOC 69W
Boring No. ZWM-95-17X
Date Installed 9/20/95
Driller K. REGAN (D.L. MAHER)
Drilling Method H.S.A.
Development Method
Field Geologist G. GULSETH



Stick-up of Casing Above Ground Surface: 2.5 FEET

Type of Surface Seal/ Other Protection:

Type of Surface Casing: PROCOVER

ID of Surface Casing: 6 INCH

Diameter of Borehole: 10 INCH

Riser Pipe ID: 4 INCH

Type of Riser Pipe: SCH 40 PVC

Type of Backfill: BENTONITE GROUT

Depth of Top of Seal: 3.0 FEET (bgs)

Type of Seal: BENTONITE PELLETS

Depth of Top of Sand: 7.0 FEET (bgs)

Depth of Top of Screen: 12.2 FEET (bgs)

Type of Screen: SCH 40 PVC

Slot Size x Length: 0.010 INCH - 10 FEET

ID of Screen: 4 INCH

Type of Sandpack: #00 SAND

Depth of Bottom of Screen: 22.2 FEET (bgs)

Depth of Sediment Sump with Plug: N/A

Depth of Bottom of Borehole: 22.5 FEET

MONITORING WELL CONSTRUCTION DIAGRAM

Project Fort Devens

Project No. 9144-02

Study Area AOC 69W

Boring No. ZWM-95-18X

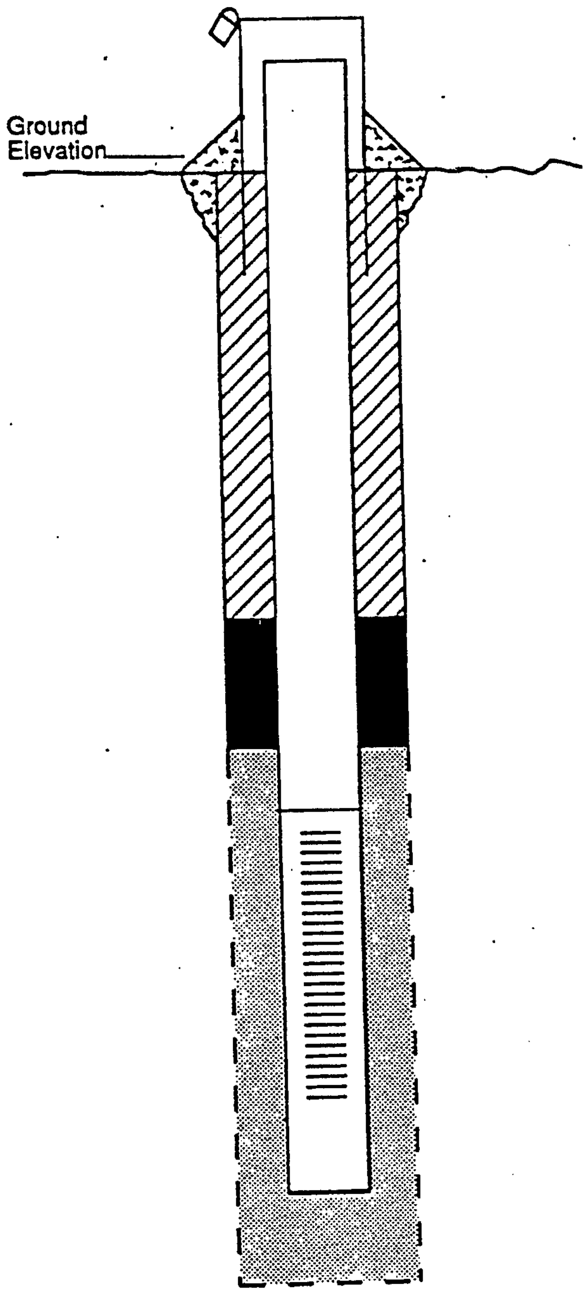
Date Installed 10-02-95

Driller D.L. MAHER — B. Burns

Drilling Method 6½" (ID) HSAs

Development Method

Field Geologist S. Montgomery



Stick-up of Casing Above Ground Surface: 2.75'

Type of Surface Seal/ Other Protection: gravel pad

Type of Surface Casing: steel

ID of Surface Casing: 6"

Diameter of Borehole: 0.9 ft

Riser Pipe ID: 4"

Type of Riser Pipe: Schedule 40 PVC

Type of Backfill: Type I-II Portland cement + Volclay high solids grout

Depth of Top of Seal: 1'

Type of Seal: ¼" bentonite pellets

Depth of Top of Sand: 2'

Depth of Top of Screen: 3'

Type of Screen: Schedule 40 PVC

Slot Size x Length: 0.010" machine slot x 10'

ID of Screen: 4"

Type of Sandpack: 20-40 silica sand

Depth of Bottom of Screen: 13'

Depth of Sediment Sump with Plug: 1'

Depth of Bottom of Borehole: 14'

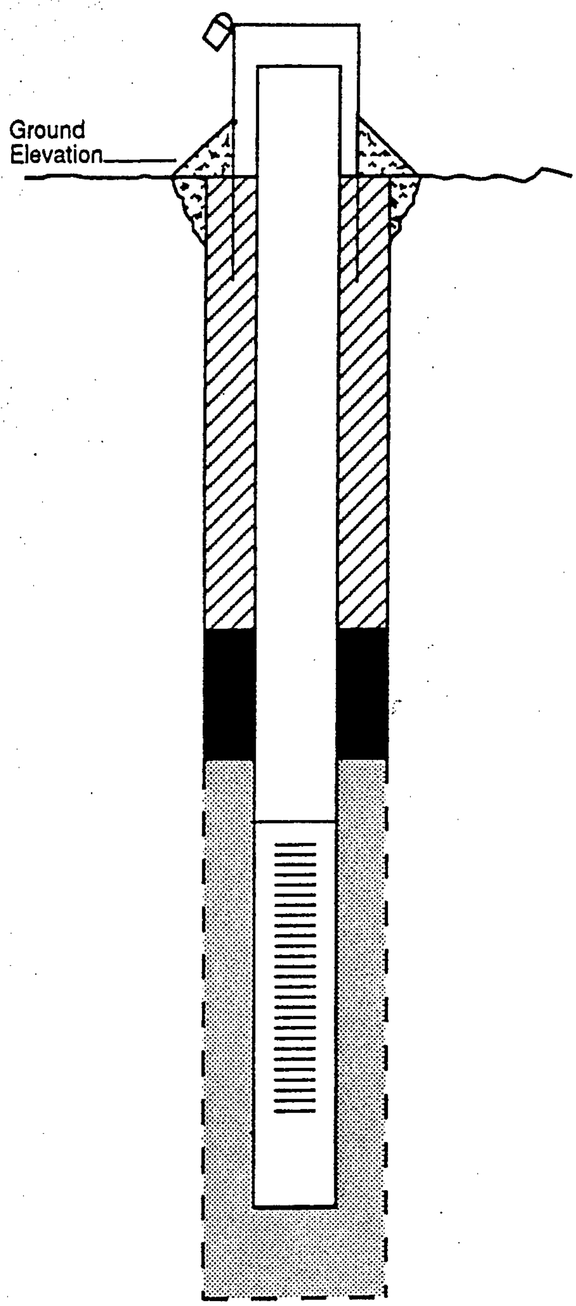
MONITORING WELL CONSTRUCTION DIAGRAM

Project Fort Devens
Study Area AOC 69W
Driller M. D'Ambrosio

Project No. 9144.08
Boring No. ZWM-96-19X
Drilling Method Drive & Wash

Date Installed 8.21.96
Development Method Pump & Surge

Field Geologist R. McCoy



Stick-up of Casing Above Ground Surface: FLUSH MOUNT

Type of Surface Seal/ Other Protection: Concrete Collar

Type of Surface Casing: 4" STEEL ROAD BOX

ID of Surface Casing: 4"

Diameter of Borehole: 4"

Riser Pipe ID: 2"

Type of Riser Pipe: SCHD. 40 PVC

Type of Backfill: CEMENT/BENTONITE GROUT RM

Depth of Top of Seal: 1.2' bgs

Type of Seal: Bentonite Chips

Depth of Top of Sand: 3.9' bgs

Depth of Top of Screen: 5.8' bgs

Type of Screen: SCHD. 40 PVC

Slot Size x Length: 10 SLOT X 10 FT

ID of Screen: 2"

Type of Sandpack: 0 SAND

Depth of Bottom of Screen: 15.8' bgs

Depth of Sediment Sump with Plug: 16.0' bgs

Depth of Bottom of Borehole: 16.0' bgs

MONITORING WELL CONSTRUCTION DIAGRAM
PROJECT OPERATIONS PLAN
FORT DEVENS, MASSACHUSETTS

ABB Environmental Services, Inc.

9312005S L16

RI REPORT SITE FIGURES AND GROUNDWATER ANALYTICAL DATA

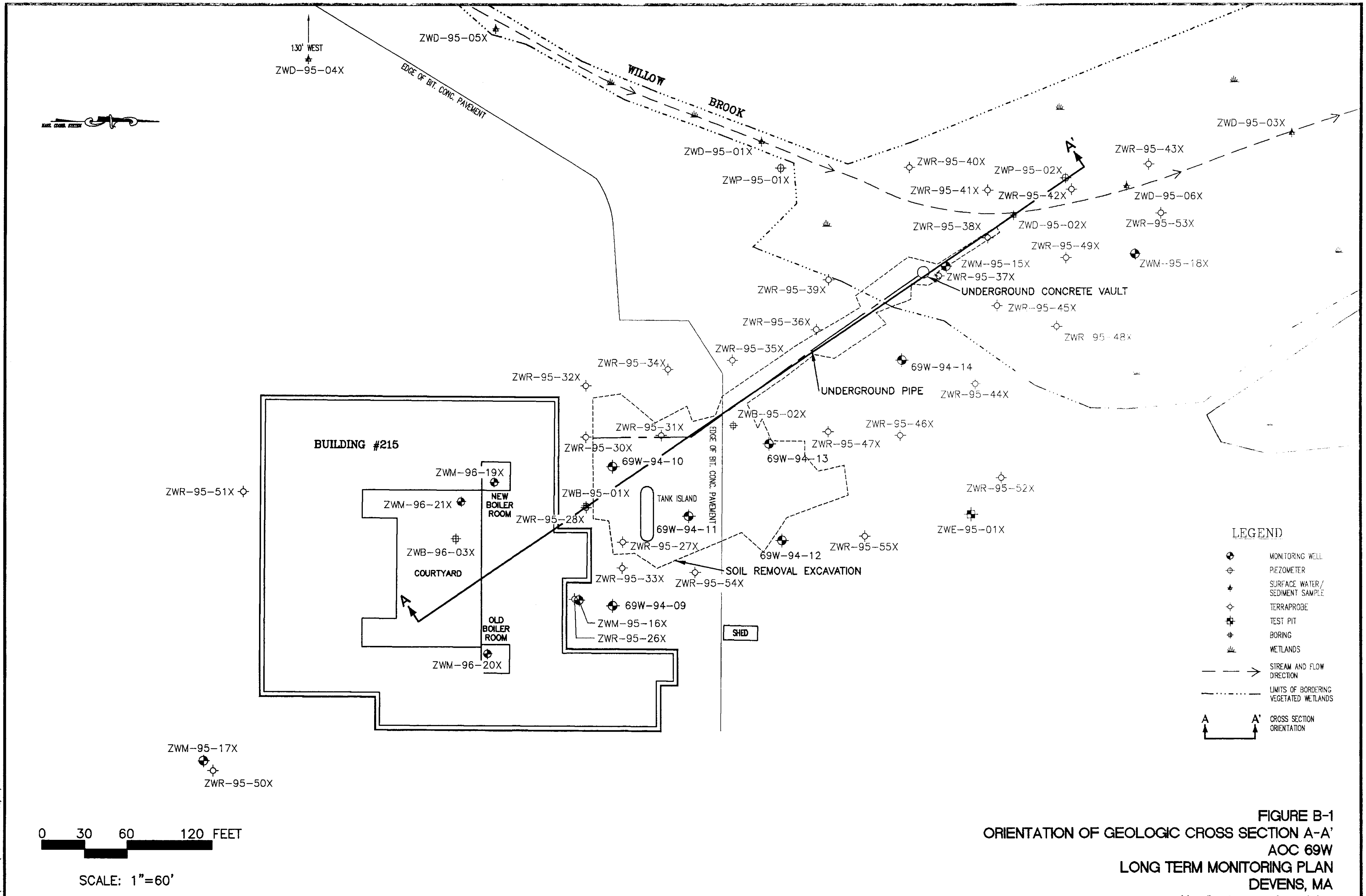


FIGURE B-1
ORIENTATION OF GEOLOGIC CROSS SECTION A-A'
AOC 69W
LONG TERM MONITORING PLAN
DEVENS, MA

Harding Lawson Associates

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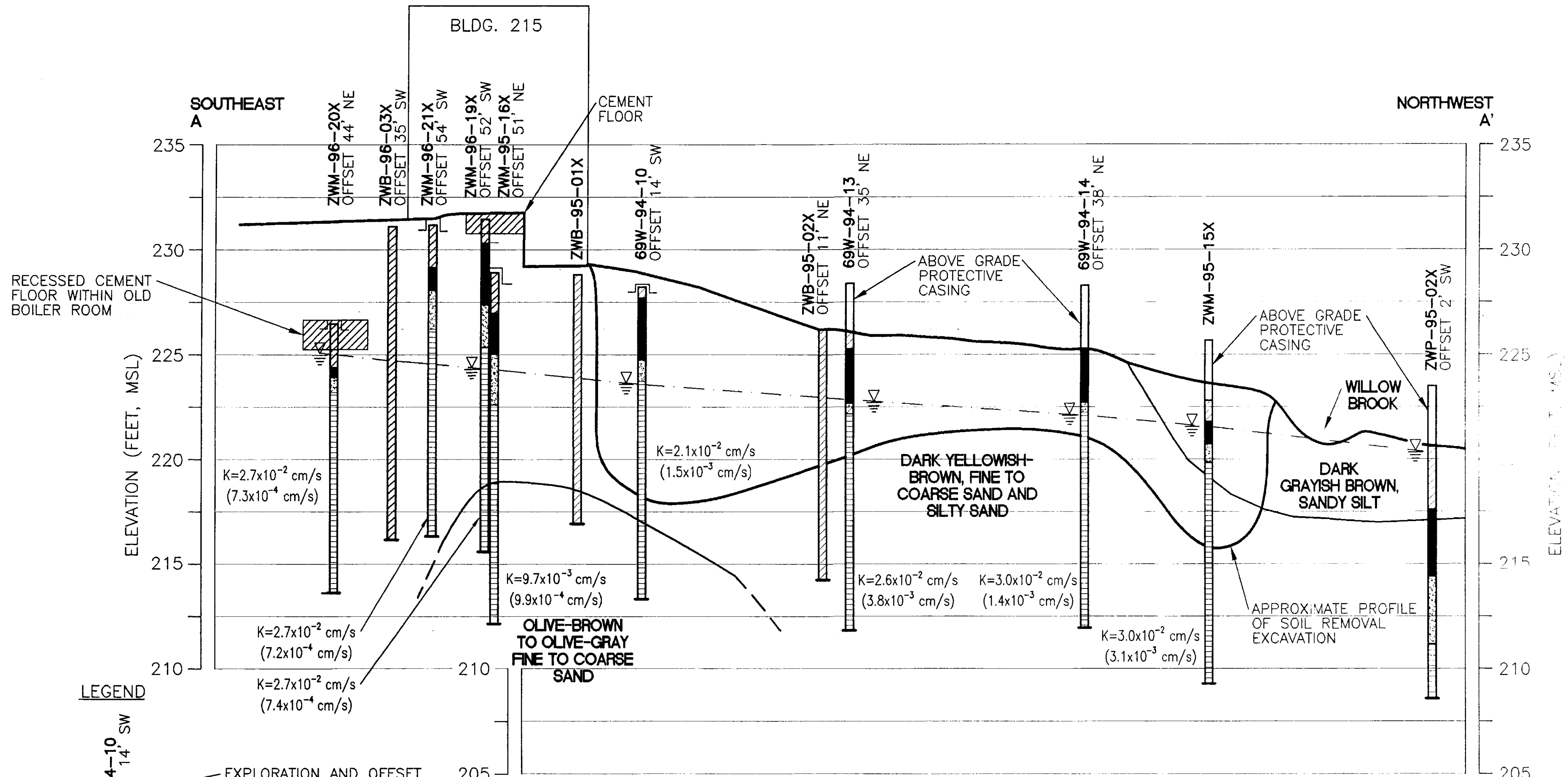
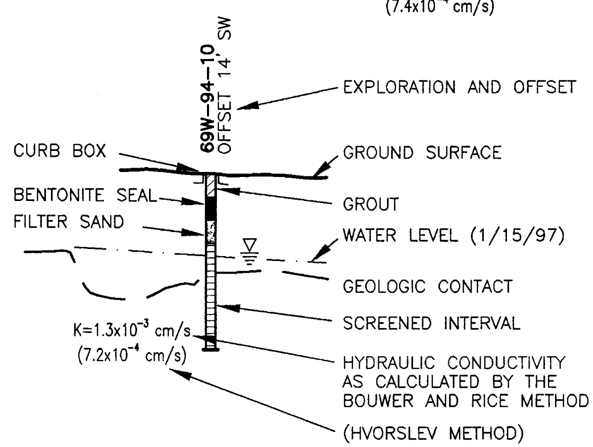


LEGEND



CROSS SECTION A - A'

NOTES:

1. FOR ORIENTATION OF CROSS SECTION, SEE FIGURE 6-1.
2. GEOLOGIC CONDITIONS BETWEEN WELLS ARE AN INTERPRETATION OF AVAILABLE DATA. ACTUAL CONDITIONS MAY VARY.
3. MSL = MEAN SEA LEVEL

0 50 100

HORIZONTAL SCALE: 1"=50'
VERTICAL SCALE: 1"=5'
VERTICAL EXAGGERATION: 10:1

FIGURE B-2
INTERPRETIVE GEOLOGIC CROSS SECTION A-A'
AOC 69W
LONG TERM MONITORING PLAN
DEVENS, MA

Harding Lawson Associates

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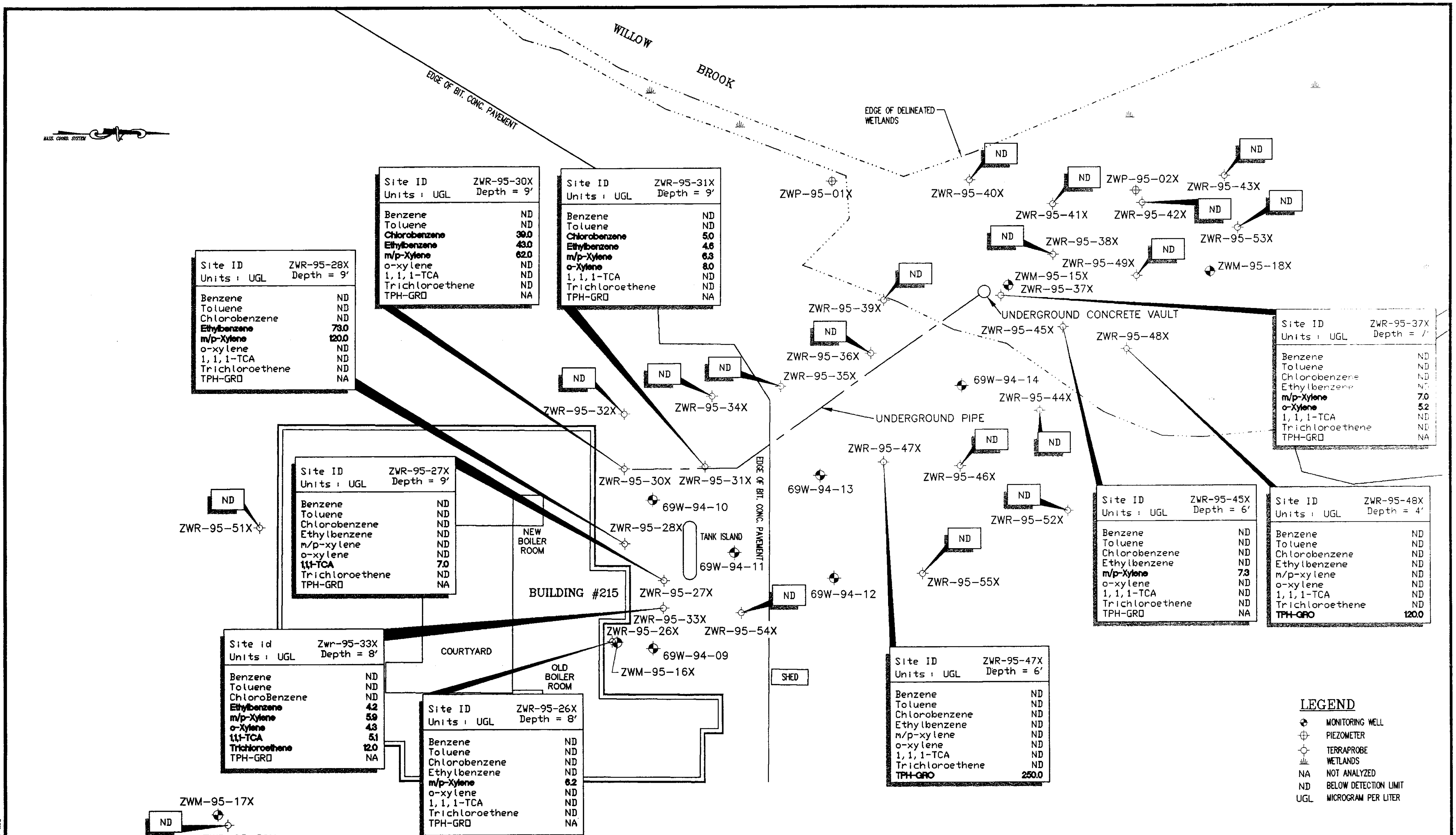

FIGURE B-9
SELECTED PAL VOCs IN GROUNDWATER
1995 FIELD ANALYTICAL RESULTS
AOC 69W
LONG TERM MONITORING PLAN
DEVENS, MASSACHUSETTS
Harding Lawson Associates

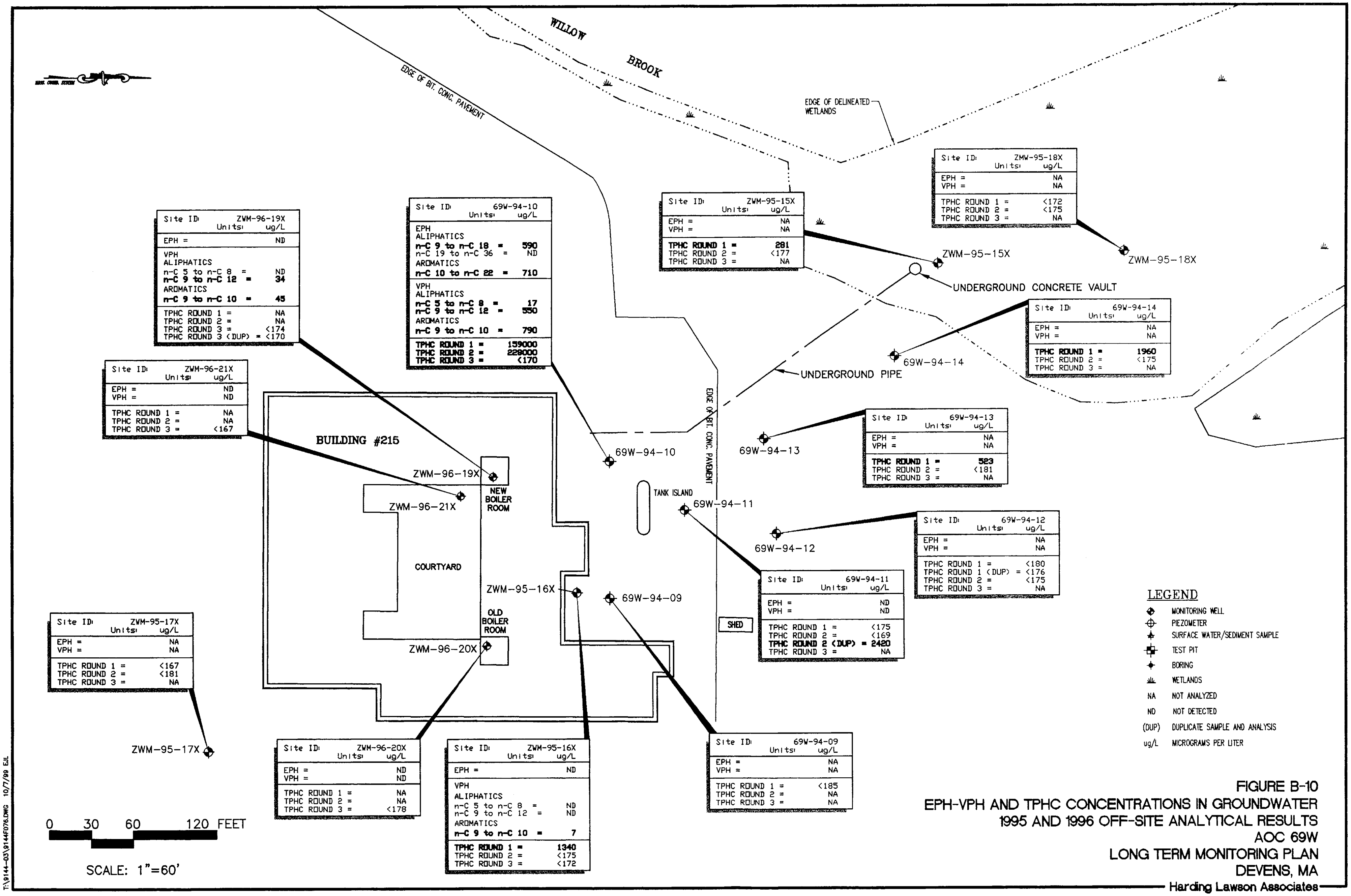

FIGURE B-10
EPH-VPH AND TPHC CONCENTRATIONS IN GROUNDWATER
1995 AND 1996 OFF-SITE ANALYTICAL RESULTS
AOC 69W
LONG TERM MONITORING PLAN
DEVENS, MA

Harding Lawson Associates

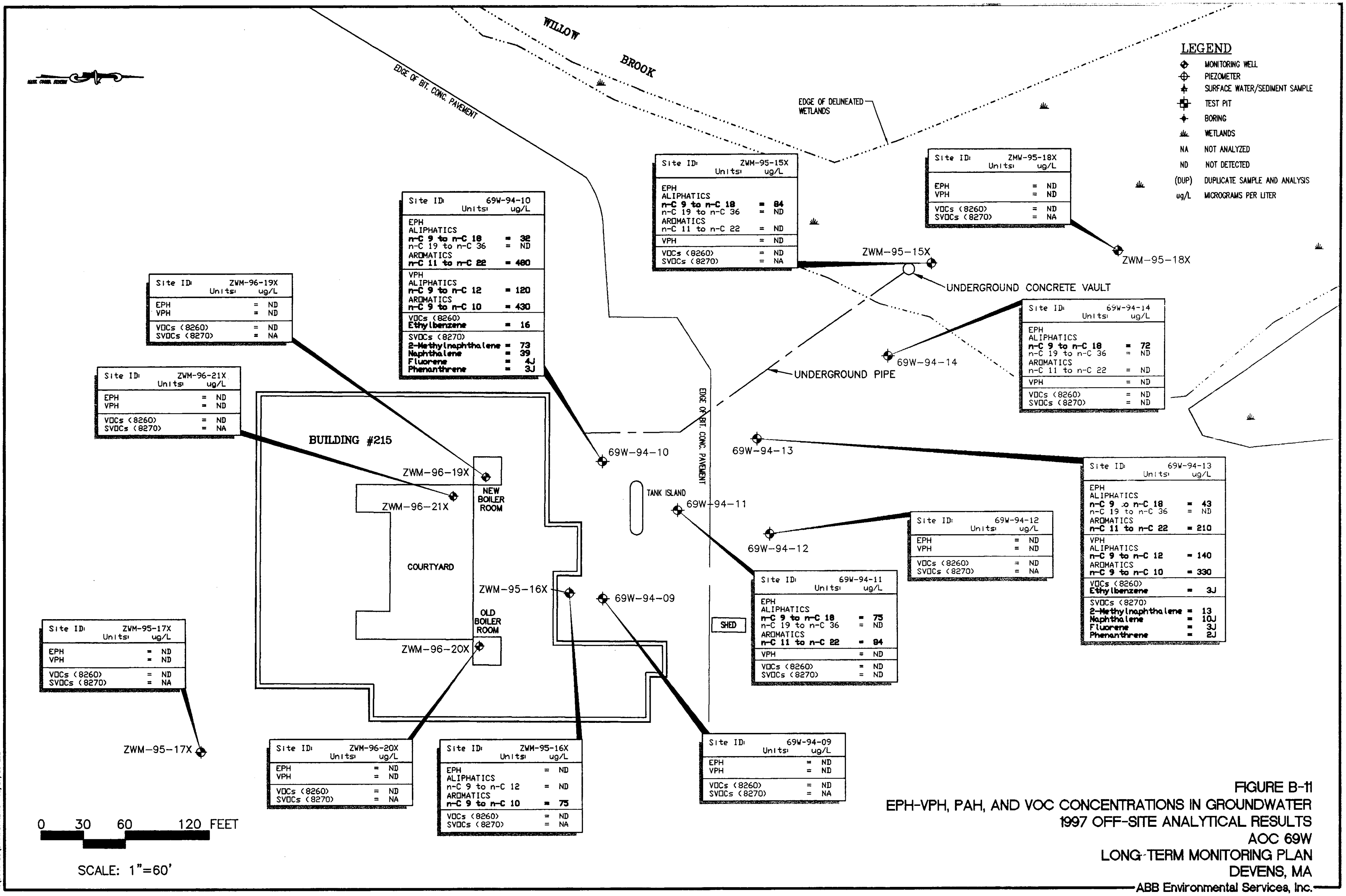

FIGURE B-11
EPH-VPH, PAH, AND VOC CONCENTRATIONS IN GROUNDWATER
1997 OFF-SITE ANALYTICAL RESULTS
AOC 69W
LONG-TERM MONITORING PLAN
DEVENS, MA

ABB Environmental Services, Inc.

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USEPA REGION I LOW STRESS (LOW FLOW) PURGING AND SAMPLING PROCEDURES

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

July 30, 1996
Revision 2

U.S. ENVIRONMENTAL PROTECTION AGENCY
REGION I

LOW STRESS (low flow) PURGING AND SAMPLING PROCEDURE FOR THE COLLECTION OF GROUND WATER SAMPLES FROM MONITORING WELLS

I. SCOPE & APPLICATION

This standard operating procedure (SOP) provides a general framework for collecting ground water samples that are indicative of mobile organic and inorganic loads at ambient flow conditions (both the dissolved fraction and the fraction associated with mobile particulates). The SOP emphasizes the need to minimize stress by low water-level drawdowns, and low pumping rates (usually less than 1 liter/min) in order to collect samples with minimal alterations to water chemistry. This SOP is aimed primarily at sampling monitoring wells that can accept a submersible pump and have a screen, or open interval length of 10 feet or less (this is the most common situation). However, this procedure is flexible and can be used in a variety of well construction and ground-water yield situations. Samples thus obtained are suitable for analyses of ground water contaminants (volatile and semi-volatile organic analytes, pesticides, PCBs, metals and other inorganics), or other naturally occurring analytes.

This procedure does not address the collection of samples from wells containing light or dense non-aqueous phase liquids (LNAPLs and DNAPLs). For this the reader may wish to check: Cohen, R.M. and J.W. Mercer, 1993, DNAPL Site Evaluation; C.K. Smoley (CRC Press), Boca Raton, Florida and U.S. Environmental Protection Agency, 1992, RCRA Ground-Water Monitoring: Draft Technical Guidance; Washington, DC (EPA/530-R-93-001).

The screen, or open interval of the monitoring well should be optimally located (both laterally and vertically) to intercept existing contaminant plume(s) or along flowpaths of potential contaminant releases. It is presumed that the analytes of interest move (or potentially move) primarily through the more permeable zones within the screen, or open interval.

Proper well construction and development cannot be overemphasized, since the use of installation techniques that are appropriate to the hydrogeologic setting often prevents "problem well" situations from occurring. It is also recommended that as part of development or redevelopment the well should be tested to determine the appropriate pumping rate to obtain stabilization of field indicator parameters with minimal drawdown in shortest amount of time. With this information field crews can then conduct purging and sampling in a more expeditious manner.

The mid-point of the saturated screen length (which should not exceed 10 feet) is used by convention as the location of the pump intake. However, significant chemical or permeability contrast(s) within the screen may require additional field work to determine the optimum vertical location(s) for the intake, and appropriate pumping rate(s) for purging and sampling more localized target zone(s). Primary flow zones (high(er) permealability and/or high(er) chemical concentrations) should be identified in wells with screen lengths longer than 10 feet, or in wells with open boreholes in bedrock. Targeting these zones for water sampling will help insure that the low stress procedure will not underestimate contaminant concentrations. The Sampling and Analysis Plan must provide clear instructions on how the pump intake depth(s) will be selected, and reason(s) for the depth(s) selected.

Stabilization of indicator field parameters is used to indicate that conditions are suitable for sampling to begin. Achievement of turbidity levels of less than 5 NTU and stable drawdowns of less than 0.3 feet, while desirable, are not mandatory. Sample collection may still take place provided the remaining criteria in this procedure are met. If after 4 hours of purging indicator field parameters have not stabilized, one of 3 optional courses of action may be taken: a) continue purging until stabilization is achieved, b) discontinue purging, do not collect any samples, and record in log book that stabilization could not be achieved (documentation must describe attempts to achieve stabilization) c) discontinue purging, collect samples and provide full explanation of attempts to achieve stabilization (note: there is a risk that the analytical data obtained, especially metals and strongly hydrophobic organic analytes, may not meet the sampling objectives).

Changes to this SOP should be proposed and discussed when the site Sampling and Analysis Plan is submitted for approval. Subsequent requests for modifications of an approved plan must include adequate technical justification for proposed changes. All changes and modifications must be approved before implementation in field.

II. EQUIPMENT

A. Extraction device

Adjustable rate, submersible pumps are preferred (for example, centrifugal or bladder pump constructed of stainless steel or Teflon).

Adjustable rate, peristaltic pumps (suction) may be used with caution. Note that EPA guidance states: "Suction pumps are not recommended because they may cause degassing, pH modification, and loss of volatile compounds" (EPA/540/P-87/001, 1987, page 8.5-11).

The use of inertial pumps is discouraged. These devices frequently cause greater disturbance during purging and sampling and are less easily controlled than the pumps listed above. This can lead to sampling results that are adversely affected by purging and sampling operations, and a higher degree of data variability.

B. Tubing

Teflon or Teflon lined polyethylene tubing are preferred when sampling is to include VOCs, SVOCs, pesticides, PCBs and inorganics.

PVC, polypropylene or polyethylene tubing may be used when collecting samples for inorganics analyses. However, these materials should be used with caution when sampling for organics. If these materials are used, the equipment blank (which includes the tubing) data must show that these materials do not add contaminants to the sample.

Stainless steel tubing may be used when sampling for VOCs, SVOCs, pesticides, and PCBs. However, it should be used with caution when sampling for metals.

The use of 1/4 inch or 3/8 inch (inner diameter) tubing is preferred. This will help ensure the tubing remains liquid filled when operating at very low pumping rates.

Pharmaceutical grade (Pharmed) tubing should be used for the section around the rotor head of a peristaltic pump, to minimize gaseous diffusion.

C. Water level measuring device(s), capable of measuring to 0.01 foot accuracy (electronic "tape", pressure transducer). Recording pressure transducers, mounted above the pump, are especially helpful in tracking water levels during pumping operations, but their use

must include check measurements with a water level "tape" at the start and end of each record.

D. Flow measurement supplies (e.g., graduated cylinder and stop watch).

E. Interface probe, if needed.

F. Power source (generator, nitrogen tank, etc.). If a gasoline generator is used, it must be located downwind and at least 30 feet from the well so that the exhaust fumes do not contaminate the samples.

G. Indicator field parameter monitoring instruments - pH, Eh, dissolved oxygen (DO), turbidity, specific conductance, and temperature. Use of a flow-through-cell is required when measuring all listed parameters, except turbidity. Standards to perform field calibration of instruments. Analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846. For Eh measurements, follow manufacturer's instructions.

H. Decontamination supplies (for example, non-phosphate detergent, distilled/deionized water, isopropyl alcohol, etc.).

I. Logbook(s), and other forms (for example, well purging forms).

J. Sample Bottles.

K. Sample preservation supplies (as required by the analytical methods).

L. Sample tags or labels.

M. Well construction data, location map, field data from last sampling event.

N. Well keys.

O. Site specific Sample and Analysis Plan/Quality Assurance Project Plan.

P. PID or FID instrument (if appropriate) to detect VOCs for health and safety purposes, and provide qualitative field evaluations.

III. PRELIMINARY SITE ACTIVITIES

Check well for security damage or evidence of tampering, record pertinent observations.

Lay out sheet of clean polyethylene for monitoring and sampling equipment.

Remove well cap and immediately measure VOCs at the rim of the well with a PID or FID instrument and record the reading in the field logbook.

If the well casing does not have a reference point (usually a V-cut or indelible mark in the well casing), make one. Describe its location and record the date of the mark in the logbook.

A synoptic water level measurement round should be performed (in the shortest possible time) before any purging and sampling activities begin. It is recommended that water level depth (to 0.01 ft.) and total well depth (to 0.1 ft.) be measured the day before, in order to allow for re-settlement of any particulates in the water column. If measurement of total well depth is not made the day before, it should not be measured until after sampling of the well is complete. All measurements must be taken from the established referenced point. Care should be taken to minimize water column disturbance.

Check newly constructed wells for the presence of LNAPLs or DNAPLs before the initial sampling round. If none are encountered, subsequent check measurements with an interface probe are usually not needed unless analytical data or field head space information signal a worsening situation. Note: procedures for collection of LNAPL and DNAPL samples are not addressed in this SOP.

IV. PURGING AND SAMPLING PROCEDURE

Sampling wells in order of increasing chemical concentrations (known or anticipated) is preferred.

1. Install Pump

Lower pump, safety cable, tubing and electrical lines slowly (to minimize disturbance) into the well to the midpoint of the zone to be sampled. The Sampling and Analysis Plan should specify the sampling depth, or provide criteria for selection of intake depth for each well (see Section I). If possible keep the pump intake at least two

feet above the bottom of the well, to minimize mobilization of particulates present in the bottom of the well. Collection of turbid free water samples may be especially difficult if there is two feet or less of standing water in the well.

2. Measure Water Level

Before starting pump, measure water level. If recording pressure transducer is used-initialize starting condition.

3. Purge Well

3a. Initial Low Stress Sampling Event

Start the pump at its lowest speed setting and slowly increase the speed until discharge occurs. Check water level. Adjust pump speed until there is little or no water level drawdown (less than 0.3 feet). If the minimal drawdown that can be achieved exceeds 0.3 feet but remains stable, continue purging until indicator field parameters stabilize.

Monitor and record water level and pumping rate every three to five minutes (or as appropriate) during purging. Record any pumping rate adjustments (both time and flow rate). Pumping rates should, as needed, be reduced to the minimum capabilities of the pump (for example, 0.1 - 0.4 l/min) to ensure stabilization of indicator parameters. Adjustments are best made in the first fifteen minutes of pumping in order to help minimize purging time. During pump start-up, drawdown may exceed the 0.3 feet target and then "recover" as pump flow adjustments are made. Purge volume calculations should utilize stabilized drawdown value, not the initial drawdown. Do not allow the water level to fall to the intake level (if the static water level is above the well screen, avoid lowering the water level into the screen). The final purge volume must be greater than the stabilized drawdown volume plus the extraction tubing volume.

Wells with low recharge rates may require the use of special pumps capable of attaining very low pumping rates (bladder, peristaltic), and/or the use of dedicated equipment. If the recharge rate of the well is lower than extraction rate capabilities of currently manufactured pumps and the well is essentially dewatered during purging, then the well should be sampled as soon as the water level has recovered sufficiently to collect the appropriate volume needed for all anticipated samples (ideally the intake should not be moved during this recovery period). Samples may then be collected even though the indicator field parameters have not stabilized.

3b. Subsequent Low Stress Sampling Events

After synoptic water level measurement round, check intake depth and drawdown information from previous sampling event(s) for each well. Duplicate, to the extent practicable, the intake depth and extraction rate (use final pump dial setting information) from previous event(s). Perform purging operations as above.

4. Monitor Indicator Field Parameters

During well purging, monitor indicator field parameters (turbidity, temperature, specific conductance, pH, Eh, DO) every three to five minutes (or less frequently, if appropriate). Note: during the early phase of purging emphasis should be put on minimizing and stabilizing pumping stress, and recording those adjustments. Purging is considered complete and sampling may begin when all the above indicator field parameters have stabilized. Stabilization is considered to be achieved when three consecutive readings, taken at three (3) to five (5) minute intervals, are within the following limits:

turbidity (10% for values greater than 1 NTU),
DO (10%),
specific conductance (3%),
temperature (3%),
pH (± 0.1 unit),
ORP/Eh (± 10 millivolts).

All measurements, except turbidity, must be obtained using a flow-through-cell. Transparent flow-through-cells are preferred, because they allow field personnel to watch for particulate build-up within the cell. This build-up may affect indicator field parameter values measured within the cell and may also cause an underestimation of turbidity values measured after the cell. If the cell needs to be cleaned during purging operations, continue pumping and disconnect cell for cleaning, then reconnect after cleaning and continue monitoring activities.

The flow-through-cell must be designed in a way that prevents air bubble entrapment in the cell. When the pump is turned off or cycling on/off (when using a bladder pump), water in the cell must not drain out. Monitoring probes must be submerged in water at all times. If two flow-through-cells are used in series, the one containing the dissolved oxygen probe should come first (this parameter is most susceptible to error if air leaks into the system).

5. Collect Water Samples

Water samples for laboratory analyses must be collected before water has passed through the flow-through-cell (use a by-pass assembly or disconnect cell to obtain sample).

VOC samples should be collected first and directly into pre-preserved sample containers. Fill all sample containers by allowing the pump discharge to flow gently down the inside of the container with minimal turbulence.

During purging and sampling, the tubing should remain filled with water so as to minimize possible changes in water chemistry upon contact with the atmosphere. It is recommended that 1/4 inch or 3/8 inch (inside diameter) tubing be used to help insure that the sample tubing remains water filled. If the pump tubing is not completely filled to the sampling point, use one of the following procedures to collect samples: (1) add clamp, connector (Teflon or stainless steel) or valve to constrict sampling end of tubing; (2) insert small diameter Teflon tubing into water filled portion of pump tubing allowing the end to protrude beyond the end of the pump tubing, collect sample from small diameter tubing; (3) collect non-VOC samples first, then increase flow rate slightly until the water completely fills the tubing, collect sample and record new drawdown, flow rate and new indicator field parameter values.

Add preservative, as required by analytical methods, to samples immediately after they are collected if the sample containers are not pre-preserved. Check analytical methods (e.g. EPA SW-846, water supply, etc.) for additional information on preservation. Check pH for all samples requiring pH adjustment to assure proper pH value. For VOC samples, this will require that a test sample be collected during purging to determine the amount of preservative that needs to be added to the sample containers prior to sampling.

If determination of filtered metal concentrations is a sampling objective, collect filtered water samples using the same low flow procedures. The use of an in-line filter is required, and the filter size (0.45 um is commonly used) should be based on the sampling objective. Pre-rinse the filter with approximately 25 - 50 ml of ground water prior to sample collection. Preserve filtered water sample immediately. Note: filtered water samples are not an acceptable substitute for unfiltered samples when the monitoring objective is to obtain chemical concentrations of total mobile contaminants in ground water for human health risk calculations.

Label each sample as collected. Samples requiring cooling (volatile organics, cyanide, etc.) will be placed into a cooler with ice or refrigerant for delivery to the laboratory. Metal samples after acidification to a pH less than 2 do not need to be cooled.

6. Post Sampling Activities

If recording pressure transducer is used, remeasure water level with tape.

After collection of the samples, the pump tubing may either be dedicated to the well for resampling (by hanging the tubing inside the well), decontaminated, or properly discarded.

Before securing the well, measure and record the well depth (to 0.1 ft.), if not measured the day before purging began. Note: measurement of total well depth is optional after the initial low stress sampling event. However, it is recommended if the well has a "silting" problem or if confirmation of well identity is needed.

Secure the well.

V.DECONTAMINATION

Decontaminate sampling equipment prior to use in the first well and following sampling of each subsequent well. Pumps will not be removed between purging and sampling operations. The pump and tubing (including support cable and electrical wires which are in contact with the well) will be decontaminated by one of the procedures listed below.

<u>Procedure 1</u>

The decontaminating solutions can be pumped from either buckets or short PVC casing sections through the pump or the pump can be disassembled and flushed with the decontaminating solutions. It is recommended that detergent and isopropyl alcohol be used sparingly in the decontamination process and water flushing steps be extended to ensure that any sediment trapped in the pump is removed. The pump exterior and electrical wires must be rinsed with the decontaminating solutions, as well. The procedure is as follows:

Flush the equipment/pump with potable water.

Flush with non-phosphate detergent solution. If the solution is

recycled, the solution must be changed periodically.

Flush with potable or distilled/deionized water to remove all of the detergent solution. If the water is recycled, the water must be changed periodically.

Flush with isopropyl alcohol (pesticide grade). If equipment blank data from the previous sampling event show that the level of contaminants is insignificant, then this step may be skipped.

Flush with distilled/deionized water. The final water rinse must not be recycled.

Procedure 2

Steam clean the outside of the submersible pump.

Pump hot potable water from the steam cleaner through the inside of the pump. This can be accomplished by placing the pump inside a three or four inch diameter PVC pipe with end cap. Hot water from the steam cleaner jet will be directed inside the PVC pipe and the pump exterior will be cleaned. The hot water from the steam cleaner will then be pumped from the PVC pipe through the pump and collected into another container. Note: additives or solutions should not be added to the steam cleaner.

Pump non-phosphate detergent solution through the inside of the pump. If the solution is recycled, the solution must be changed periodically.

Pump potable water through the inside of the pump to remove all of the detergent solution. If the solution is recycled, the solution must be changed periodically.

Pump distilled/deionized water through the pump. The final water rinse must not be recycled.

VI.FIELD QUALITY CONTROL

Quality control samples are required to verify that the sample collection and handling process has not compromised the quality of the ground water samples. All field quality control samples must be prepared the same as regular investigation samples with regard to sample volume, containers, and preservation. The following quality control samples shall be collected for each batch of samples (a batch

may not exceed 20 samples). Trip blanks are required for the VOC samples at a frequency of one set per VOC sample cooler.

Field duplicate.

Matrix spike.

Matrix spike duplicate.

Equipment blank.

Trip blank (VOCs).

Temperature blank (one per sample cooler)..

Equipment blank shall include the pump and the pump's tubing. If tubing is dedicated to the well, the equipment blank will only include the pump in subsequent sampling rounds.

Collect samples in order from wells with lowest contaminant concentration to highest concentration. Collect equipment blanks after sampling from contaminated wells and not after background wells.

Field duplicates are collected to determine precision of sampling procedure. For this procedure, collect duplicate for each analyte group in consecutive order (VOC original, VOC duplicate, SVOC original, SVOC duplicate, etc.).

If split samples are to be collected, collect split for each analyte group in consecutive order (VOC original, VOC split, etc.). Split sample should be as identical as possible to original sample.

All monitoring instrumentation shall be operated in accordance with EPA analytical methods and manufacturer's operating instructions. EPA analytical methods are listed in 40 CFR 136, 40 CFR 141, and SW-846 with exception of Eh, for which the manufacturer's instructions are to be followed. Instruments shall be calibrated at the beginning of each day. If a measurement falls outside the calibration range, the instrument should be re-calibrated so that all measurements fall within the calibration range. At the end of each day, check calibration to verify that instruments remained in calibration. Temperature measuring equipment, thermometers and thermistors, need not be calibrated to the above frequency. They should be checked for accuracy prior to field use according to EPA Methods and the manufacturer's instructions.

VII.FIELD LOGBOOK

A field log shall be kept to document all ground water field monitoring activities (see attached example matrix), and record all of the following:

Well identification.

Well depth, and measurement technique.

Static water level depth, date, time and measurement technique.

Presence and thickness of immiscible liquid (NAPL) layers and detection method.

Pumping rate, drawdown, indicator parameters values, and clock time, at the appropriate time intervals; calculated or measured total volume pumped.

Well sampling sequence and time of each sample collection.

Types of sample bottles used and sample identification numbers.

Preservatives used.

Parameters requested for analysis.

Field observations during sampling event.

Name of sample collector(s).

Weather conditions.

QA/QC data for field instruments.

Any problems encountered should be highlighted.

Description of all sampling equipment used, including trade names, model number, diameters, material composition, etc.

VIII. DATA REPORT

Data reports are to include laboratory analytical results, QA/QC information, and whatever field logbook information is needed to allow for a full evaluation of data useability.

Page ____ of ____

EXAMPLE (Minimum Requirements)

Well PURGING-FIELD WATER QUALITY MEASUREMENTS FORM

Location (Site/Facility Name) ____________________
Well Number ____________ Date ____________
Field Personnel ____________________
Sampling Organization ____________________
Identify MP ____________________

Depth to (below MP) ______ top / ______ bottom of screen
Pump Intake at (ft. below MP) ____________
Purging Device; (pump type) ____________

Clock Time 24 HR	Water Depth below MP ft	Pump Dial[1]	Purge Rate ml/min	Cum. Volume Purged liters	Temp. °C	Spec. Cond.[2] μS/cm	pH	ORP/ Eh[3] mv	DO mg/L	Turb-idity NTU	Comments

1. Pump dial setting (for example: hertz, cycles/min, etc).
2. μSiemens per cm(same as μmhos/cm)at 25°C.
3. Oxidation reduction potential (stand in for Eh).

GROUNDWATER SAMPLING CHECKLIST

APPENDIX D
GROUNDWATER SAMPLING CHECKLIST

AOC 69W LONG TERM MONITORING PLAN
DEVENS, MASSACHUSETTS

SAMPLING PROCEDURE	COMPLETED?
Presampling	
Property owner contacted	
Laboratory contacted 2 weeks prior to sampling	
Laboratory sample kit, cooler received	
Equipment obtained	
Keys to well locks obtained	
Sampling (each well)	
Headspace readings taken	
Depth to groundwater level taken (all wells measured same day)	
Well purged	
Samples collected	
Duplicate sample collected (most contaminated well)	
Equipment sample collected (one only; after sampling a contaminated well)	
Labels completed	
Chain of Custody seal placed on cooler	
Chain of Custody completed	
Samples shipped within 24 hours	
Report received from laboratory	
Laboratory report forwarded to USEPA and MADEP within 60 days of sampling	

FIELD DATA RECORD – LOW FLOW GROUNDWATER SAMPLING

FIELD DATA RECORD - LOW FLOW GROUNDWATER SAMPLING

PROJECT: AOC 69W Long Term Monitoring | FIELD SAMPLE NUMBER: | ROUND NO.:

SITE ID: | SITE TYPE: WELL | DATE:

ACTIVITY: START END | JOB NUMBER: | FILE TYPE:

WATER LEVEL / PUMP SETTINGS

MEASUREMENT POINT
- ☐ TOP OF WELL RISER
- ☐ TOP OF PROTECTIVE CASING
- ☐ OTHER ______

PROTECTIVE CASING STICKUP (FROM GROUND): FT

PROTECTIVE CASING / WELL DIFFERENCE: FT

INITIAL DEPTH TO WATER: FT

WELL DEPTH (TOR): FT

PID AMBIENT AIR: PPM

WELL DIAMETER: IN

FINAL DEPTH TO WATER: FT

SCREEN LENGTH: FT

PID WELL MOUTH: PPM

WELL INTEGRITY:	YES	NO	N/A
CAP			
CASING			
LOCKED			
COLLAR			

DRAWDOWN VOLUME: GAL
(initial - final x 0.16 {2-inch} or x 0.65 {4-inch})

RATIO OF DRAWDOWN VOLUME TO TOTAL VOLUME PURGED:

PRESSURE TO PUMP: PSI

TOTAL VOL. PURGED: GAL
(purge rate (milliliters per minute) x time duration (minutes) x 0.00026 gal/milliliter)

REFILL TIMER SETTING:

DISCHARGE TIMER SETTING:

PURGE DATA

TIME	DEPTH TO WATER (ft)	PURGE RATE (ml/m)	TEMP. (deg. c)	SPECIFIC CONDUCTANCE (umho/cm)	pH (units)	DISS. O2 (mg/L)	TURBIDITY (ntu)	REDOX (mv)	PUMP INTAKE DEPTH (ft)	COMMENTS

EQUIPMENT DOCUMENTATION

TYPE OF PUMP	TYPE OF TUBING	TYPE OF PUMP MATERIAL	TYPE OF BLADDER MATERIAL
☐ QED BLADDER	☐ TEFLON OR TEFLON LINED	☐ POLYVINYL CHLORIDE	☐ TEFLON
☐ SIMCO BLADDER	☐ HIGH DENSITY POLYETHYLENE	☐ STAINLESS STEEL	☐ OTHER ______
☐ OTHER ______	☐ OTHER ______	☐ OTHER ______	

ANALYTICAL PARAMETERS

	METHOD NUMBER	FRACTION CODE	PRESERVATION METHOD	VOLUME REQUIRED	SAMPLE COLLECTED	SAMPLE BOTTLE ID NUMBERS
☐ VOC	SW 8260		HCL / 4 DEG. C	3 X 40 ML	☐	/ /
☐ SVOC	SW 8270 C		4 DEG. C	2 X 1 L AG	☐	/ /
☐ EPH	MADEP METHOD		HCL / 4 DEG. C	2 X 1 L AG	☐	/ /
☐ VPH	MADEP METHOD		HCL / 4 DEG. C	3 X 40 ML	☐	/ /
☐ PEST / PCBs	608		4 DEG. C	2 X 1 L AG	☐	/ /
☐ INORGANICS	(see notes)		HNO3 to pH <2	1 x 1 L P	☐	/ /
☐ SULFATE NITRATE/NITRITE	USEPA 300		4 DEG. C	1 X 50 ML P	☐	/ /
☐ SULFIDE	USEPA 376.1		NAOH to pH >9	1 X 500 ML P	☐	/ /
☐ FERROUS IRON	FIELD METHOD		--	--	☐	/ /
☐ TOTAL PHOSPHORUS	USEPA-365.4		H2SO4 to pH <2	1 X 50 ML P	☐	/ /
☐ AMMONIA NIROGEN	USEPA-350.1		H2SO4 to pH <2	1 X 400 ML P	☐	/ /
☐ TOC	USEPA-415.1		H2SO4 to pH <2	1 X 500 ML AG	☐	
☐ TSS ONLY	USEPA-160.2		4 DEG. C	1 X 1 L P	☐	/ /
☐ METHANE / CARBON DIOXIDE					☐	/ /

PURGE OBSERVATIONS

PURGE WATER CONTAINERIZED YES NO

NUMBER OF DRUMS GENERATED ______

LOCATION SKETCH

NOTES (1) INORGANICS: Fe & Mn (USEPA Method 200.7); As (USEPA Method 206.2)

SIGNATURE: ______________________